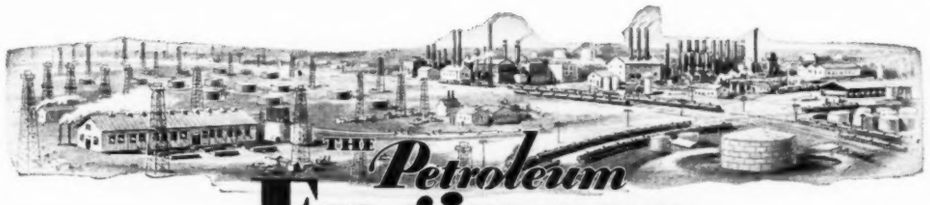

THE Petroleum Engineer

The Engineering Magazine of the Oil and Gas Industry

Edited and Circulated Only for those Actively Engaged in the Operating Departments of the Industry

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This issue contains

	Page
The Month's Highlights in Oildom By J. L. Dwyer	13
Wells in Old Field Produce Through Small Tapered Tubing By K. C. Sclater	14
Methods of Treating High Octane Gasoline By F. R. Staley	18
Mechanical Ingenuity and Practical Engineering Conquers Three-Year Roumanian Well Fire By Warren L. Baker	20
Construction Costs Lowered by Close Inspection of Welding By J. H. Dameron	23
Controlling Gravity and Preparing Crude for Pipe Line Requirements on the Lease By Charles P. Buck	25
An Interesting Plugging Back Job Completed With New Tool	28
Effect of Size on the Performance of Drilling Bits By R. A. Silent	30
General Operating Conditions of New West Kansas Area	32
Very Latest Design Features Sinclair's East Texas Pumping Rigs	34
Rigid Specifications Adhered to in Foundation and Cellar Construction at East Texas Lake Well	54
Calculation of Heat Balance for Gas Fired Boilers By E. F. Dawson	58
Natural Gasoline Plant Flexibility By Anson W. Dwen	61
Selection and Handling of Grease Plant Raw Materials By Dr. Wm. T. Sieber	72
Short Tube Condensers in Refinery and Natural Gasoline Plant Service By L. J. Coulthurst and L. P. Scoville	76
Jackson, Mississippi, Easy Drilling Area By Frank H. Love	81
The Application of Synchronous Motors to the Oil Industry By T. D. Williamson	118

REGULAR DEPARTMENTS

Pictorial Petroleum	**Pages 99 to 106, inclusive**
Latest Activities in the Oil Fields	**36, 38, 39 and 40**
Progress of Major Pipe Line Work	**42 and 44**
The Month's Activities in Refining	**46**
Running Tour With Men in the Industry	**92 and 94**
New Petroleum Equipment	**84, 87, 88 and 90**
Laugh With Barney	**97**
Strange But True Happenings in the Petroleum Industry	**70**
New Patents of the Industry	**120**

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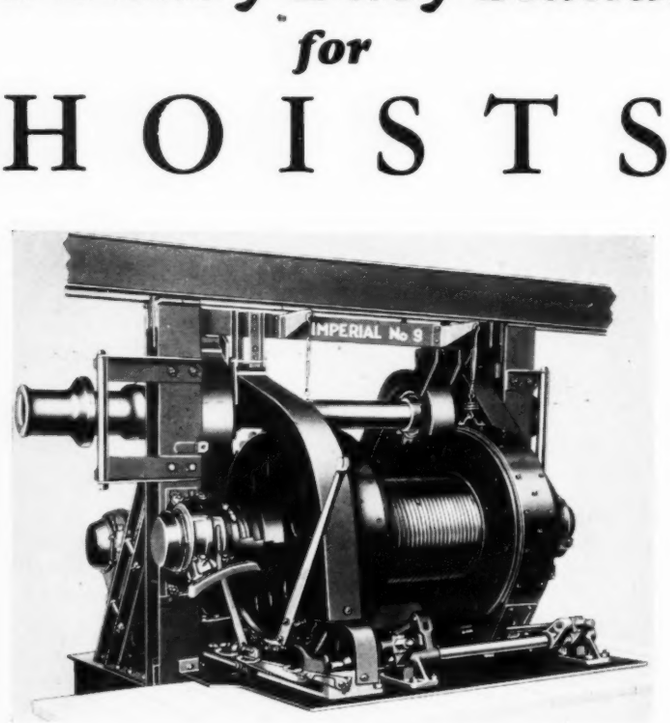

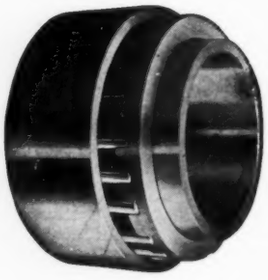

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The Month's HIGH LIGHTS *in* OILDOM

By J. L. DWYER

APRIL first witnessed an advance in the posted price for crude oil in the Mid-Continent territory, an advance amounting to fifteen cents a barrel on all grades of crude. The present posted price is 92 cents per barrel for 36 gravity oil, and as a result of the new price a feeling of optimism prevails.

The price increase was announced by the Continental Oil Co. of Ponca City, Okla. This concern once before took the initiative in establishing new price conditions. In former years, any price changes were generally announced by one of the larger crude oil purchasing agencies, but the last two changes have been made by Continental.

The new price structure was adopted by practically all of the crude purchasers, and in Oklahoma, Kansas and North Central Texas, oil prices now range from 76 cents for oil below 29 gravity, to a top price of $1.00 per barrel for crude of 40 gravity and above.

Conflicting reports continue to originate regarding the East Texas field, many claiming that the steadily declining pressure indicates that the region is decreasing in importance. Regardless of the pressure in East Texas, this great field must not be held too lightly, as it certainly is capable of producing a vast quantity of oil. At this time there are more than 4700 completed wells in the field, and as long as the field is produced at the current rate, it will have no disturbing effect on the crude market.

The Western Petroleum Refiners' Association convention, held early in April at Excelsior Springs, Mo., aroused much interest. There were several important papers presented at the meeting, and a discussion of octane numbers was given much attention. The effects of this discussion will probably have a broad influence upon several matters pertaining to the refining branch of the industry for the remainder of this year.

The gasoline price situation shows a marked improvement, and has given the refining and marketing branches of the industry some reason for optimism. At the start of this year, the refiner in the Mid-Continent territory was obtaining two and one-half cents a gallon for gasoline; and at present (April 9) the average price recorded is four and one-quarter cents. Kerosene also has displayed an improved price tone.

The Texas Railroad Commission meeting at Austin, Texas, April 4, ruled that the daily allowable oil production of the entire state was to be held at 860,000 barrels. This is practically unchanged.

Secretary of the Interior Wilbur, during the past month, issued an order throwing the public domain of 180,000,000 acres of land open to the drill. The work of developing these lands is to be conducted under the unit plan. This is the first time that oil prospecting has been permitted on the public lands since 1929.

In southwest Texas a new pool evidently has been opened by Heard and Heard whose No. 1 Goodrich in Starr County is reported good for 200 barrels daily. The depth of this well is 1350 feet and it is located two miles north of Rio Grande City.

On the Pacific Coast the daily average oil production of California continues to hold at the half-million-barrel figure.

The Oklahoma fields continue to be very quiet. There has been some slight increase in the activity of the Oklahoma City pool, but aside from that, little new work is observed. The Oklahoma Corporation Commission placed the daily allowable output of the state at 452,000 barrels for the second quarter of the year.

Production and Refining Figures Furnished by the American Petroleum Institute

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks, Week Ending March 26, 1932

(Figures in barrels of 42 gallons each)

DISTRICT	Per Cent Potential Capacity Reporting	Daily Average Crude Runs to Stills	Per Cent Operated of Total Capacity Reporting	Gasoline Stocks	Gas and Fuel Oil Stocks
East Coast	100.0	445,400	70.3	6,680,000	5,705,000
Appalachian	91.8	92,000	67.0	1,859,000	1,148,000
Ind., Ill., Ky.	98.9	303,700	70.4	6,369,000	3,980,000
Okla., Kans., Mo.	89.6	233,300	53.6	4,033,000	2,970,000
Texas	91.3	452,900	59.2	9,194,000	9,011,000
Louisiana-Arkansas	98.9	145,900	63.3	1,833,000	4,278,000
Rocky Mountain	89.4	33,700	23.4	2,049,000	638,000
California	97.1	469,100	52.8	14,709,000	96,443,000
Total Wk. Mar. 26	95.2	2,176,000	59.4	46,726,000	124,173,000
Total Wk. Mar. 19	95.2	2,085,000	56.9	46,428,000	124,120,000
Total Mar. 28, 1931	95.7	2,332,400	65.3	*47,444,000	127,268,000
The Texas and Louisiana Gulf Coast figures shown below are included above in the totals of their respective districts.					
Texas Gulf Coast	99.8	360,600	67.8	7,504,000	6,355,000
La. Gulf Coast	100.0	106,400	72.1	1,697,000	3,624,000

Daily Average Production

(Figures in Barrels)

	March 26, 1932	Feb. 27, 1932	March 28, 1931
Oklahoma	435,900	431,900	552,800
Kansas	98,750	100,250	109,300
Panhandle Texas	46,750	47,600	55,550
North Texas	49,650	47,300	57,800
West Central Texas	24,950	23,650	25,350
West Texas	174,450	178,750	243,500
East Central Texas	55,250	54,600	56,900
East Texas	327,750	304,750	122,100
Southwest Texas	54,300	51,200	62,750
North Louisiana	27,900	28,200	39,700
Arkansas	34,150	33,850	46,700
Coastal Texas	109,050	109,700	151,250
Coastal Louisiana	28,300	26,150	26,100
Eastern (not including Mich.)	103,050	101,700	101,700
Michigan	13,950	13,700	8,550
Wyoming	39,800	36,900	40,800
Montana	6,300	7,700	8,900
Colorado	3,550	3,600	4,200
New Mexico	37,150	37,350	41,000
California	492,100	499,200	530,400
Total	2,163,050	2,138,050	2,275,350

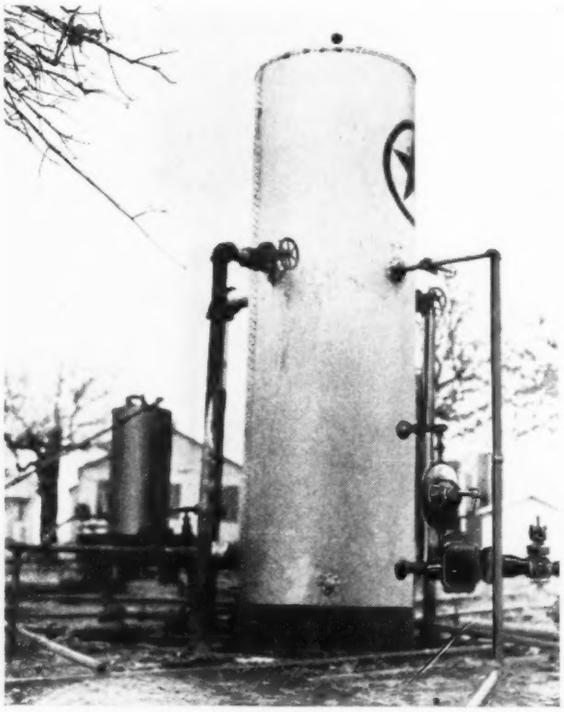
NOTE: Stocks at refineries, except in California district, which includes stocks of finished gasoline and engine distillate at refineries, water terminals and sales distributing stations and amounts in transit thereto.

*This figure is not entirely comparable with current stocks due to revisions made since original publication of this figure, for which revisions the basic information is not available by weeks. If it were possible to have made the revision, the new figure would reflect somewhat lower stocks.

WELLS *in* OLD FIELD PRODUCE TH TAPERED TUBING *from* DEPTH *of*

INTEREST attaches to the operation of a group of small oil wells flowing through small tapered tubing from a depth of 2,500 feet in a field, the rock pressure of which has declined to 430 pounds. They range in daily productive capacity from 5 to 25 barrels. The tapered tubing, which ranges in diameter from ⅜ inch to 1 inch, is run inside the 2-inch tubing through which the wells formerly were pumped. The first installation of small tapered tubing, made in March, 1931, somewhat in the nature of an experiment, proved successful. So encouraging were the results that other wells were similarly equipped and today, with the exception of two key wells, every well on the lease and two wells on adjoining leases, fourteen in all, are flowing through tapered tubing. Before this time all had been produced by pumping for several years.

Reduction of production costs was the main object in view. It was a serious attempt to increase the economic life of the wells, hence of the property, by lower cost operation that would also result in increased revenue return over the remaining life of the property. Because of the promising results already obtained, and the fact that the conditions in this shallow pool in the Atlantic field in the heart of Osage County, Oklahoma, are typical of those encountered in many old fields in almost any oil-producing region, the possibilities of this method of producing small oil wells in pools of relatively low rock pressure invite attention. Aside from the practical aspects of flowing small wells it is of more than passing interest to have some idea of the limitations of the method and the important details of procedure followed in the preliminary field work of investigating the extent of a well's adaptability to tubing flow.



Separator used on the lease into which all flowing wells produce.

One of the interesting features of the work of putting those wells on tubing flow is the originality of the method pursued in designing the tapered flow string. This was briefly outlined in a paper[1] read before the A. I. M. E. several months ago. Hawkins, the author, has succeeded in taking the available theoretical and experimental data at his disposal and combining them with sound, practical information, culled from his own observation and experience, to work out a thoroughly practical method of designing a tapered flow string to meet the well conditions in this field.

A brief review of his method would not be amiss here.

Knowing from available experimental data[2] the minimum operating pressure necessary for lifting water from a gas well of a given depth through a siphon line, assuming isothermal expansion of the gas, and how this pressure is modified by "exponential" flow—the character of flow generally believed to obtain in oil wells—Hawkins arrives at this minimum operating pressure by the empirical formula:

$$P = \frac{D}{8H}$$

where P = minimum operating pressure in pounds per square inch.

D = total depth of well in feet.

H = head in feet for a given gravity of oil or other liquid.

To take care of possible energy losses and well conditions that cannot be accurately determined, the minimum operating pressure assumed by Hawkins when designing the tapered tubing, is really higher than that given by the empirical formula, the amount of increase being based on experience. The higher the fill-up pressure above the required minimum, the greater will be the efficiency of the lift, hence, so long as there is no serious reduction in the rate of oil production, a reasonably high fill-up pressure is desirable.

Field tests are made on gas volumes produced at various well pressures and curves plotted. From this information the size of flow string is determined.

In his method of arriving at the proper design of tapered string, Hawkins contributes some original thought. Friction and slippage being among the greatest sources of energy losses in flowing wells, he provides in his design for holding these to a negligible amount by maintaining the velocity of the gas within an "efficient range" on its way to the surface. The lower limit of efficient velocity is set at five feet per second, just beyond the minimum velocity necessary for the gas to carry the oil to the surface. The upper limit is set at thirty feet per second, a velocity beyond which the friction and slippage losses are excessive for economical operation. Even thirty feet per second is high, but other practical considerations of flexibility make this a desirable upper limit. To facilitate the selection of the proper size and length of the component parts of the tapered string of tubing, velocity-pres-

[1] "Flowing Wells With Small Tubing" by R. R. Hawkins, Division Engineer, The Texas Company, Tulsa, Oklahoma.—A paper read before the Petroleum Division, A. I. M. E., October, 1931, meeting, held at Houston, Texas.

[2] "Design and Operation of Gas Well Siphons" by I. B. Williams, R. R. Brandenthaler and Morgan Walker. U. S. B. M. Technical Paper 460, 1929.

THROUGH SMALL *of* 2500 FEET : : :

By
K. C. SCLATER

sure curves are plotted on logarithmic paper for small tubing of various diameters and various gas volumes. On the curves are clearly marked the limits of the efficient range of velocity. Always keeping within these limits of velocity, the length of each size tubing in the tapered string is determined by the proportional amount of the total expansion that occurs in that particular length and size tubing. In other words, the length of each size tubing bears the same ratio to the total length of tapered string, that the amount of expansion occurring in that particular size bears to the total expansion that the gas undergoes between the bottom and top of the tapered string of tubing. This, in brief, covers the method used by Hawkins to determine the proper size tapered tubing. It is a simple method stripped of all unnecessary refinements. For instance, so small is the space occupied by the oil compared to that occupied by the gas that the effect of the presence of oil on velocity of the gas in the flow string at the bottom of the tubing is negligible, and therefore was not considered. Neither was the weight of the column of gas taken into account, because at the relatively low casing pressure in these shallow wells, the change in bottom-hole velocities is so small it can be disregarded without introducing any serious error. It was also assumed that all the gas is in the gaseous phase at the bottom of the hole. This is not strictly correct as analyses of the casinghead gas showed that it contained about twenty-five per cent of wet gas constituents, some of which would be a liquid at bottom-hole pressure.

Typical hook-up at a well flowing through small tapered tubing run in two-inch tubing. Note the pressure gauges used for taking daily readings.

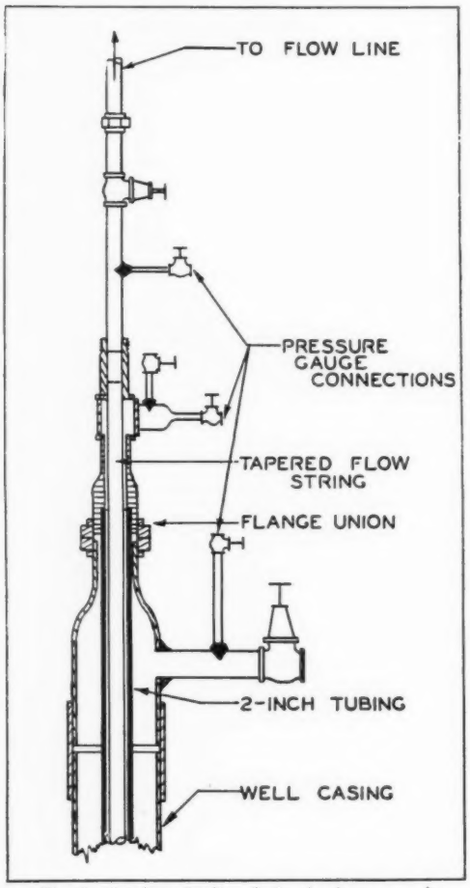
All wells in this pool have been produced by jack-pumping for several years. In November, 1929, return of dry gas to the sand through two key wells was started in order to retard the decline of rock pressure. The present average injection pressure at the key well is 415 pounds and the average total daily volume of gas returned to the sand about 500,000 cubic feet. No appreciable decline in rock pressure has been observed since gas injection was begun about two and a half years ago.

Field tests were started in February, 1931, to ascertain with some degree of accuracy the volume of gas produced by individual wells while pumping at various well pressures. It was found that all wells had sufficient pressure and gas volume to produce by natural flow through small tapered tubing. In March, 1931, the first small tapered string of tubing was installed. It was run inside the two-inch tubing already in the well. The eleven remaining wells on this lease were subsequently equipped with small tapered strings of tubing run inside the regular two-inch pumping string in the well. All this work was accomplished without interrupting the lease production schedule. It was realized that by putting the wells on natural flow the daily rate of production might be reduced, but an increase in revenue per barrel of oil produced was sought rather than an increase in rate of production.

One of the first and most important steps was to test the volume of gas produced by the wells at the pressure necessary to flow them. This was done while the wells were pumping. No special preparation was necessary to prepare the wells for test other than to see that the tubing was securely packed off and there were no leaks at the casinghead. A bleeder or blow-off valve and a recording pressure gauge on the casing, and an orifice meter, comprised the test equipment used at the well. First the well was completely pumped off and then, with the casing closed and the pump operating at a rate just sufficient to keep the well pumped down, the pressure was allowed to build up in the casing until the minimum operating pressure determined by the empirical formula, $P = \frac{D}{8H}$, was reached. This pressure was then maintained on the casing by regulating the release of gas through the blow-off valve. As soon as the casing pressure and pumping conditions in the well became steady, a production test was made by passing the oil and gas through a test trap, and recording the quantity of oil and gas produced. The volume of gas coming through the casing was also measured through an orifice meter, and the amount added to the gas produced through the tubing. This gave the total quantity of gas and oil that the well was capable of producing at the minimum operating pressure required for natural flow. Three or four more similar production tests were made successively on the well at increasingly higher casing pressures of twenty-five-pound intervals. Each time care was taken to see that conditions in the well were steady before gas volumes were measured. From this information a curve of the well's productive capacity at various casing pressures was obtained. It is obvious that a limiting condition for natural flow is that the maximum well pressure be above the required minimum operating pressure. An accurate gauge of the oil production should be taken for several days before and after the test.

Irregularity of pump operation resulting from gas-locking must be guarded against as it will destroy the accuracy of the data and give a wholly fictitious value of the well's productive capacity. This possibility suggests the desirability of using, if available, a bottom-hole pressure gauge of the

recording type for obtaining a reliable index of a well's capacity. Fortunately, there was no trouble from this source encountered in these small wells. A reasonably accurate measurement of the gas produced with the oil can be obtained by running the oil into a vapor-tight stock tank, if there is no trap on the lease. In many old pumping wells the volume of gas produced with the oil might be so small as to be negligible so far as considering its measurement is concerned.



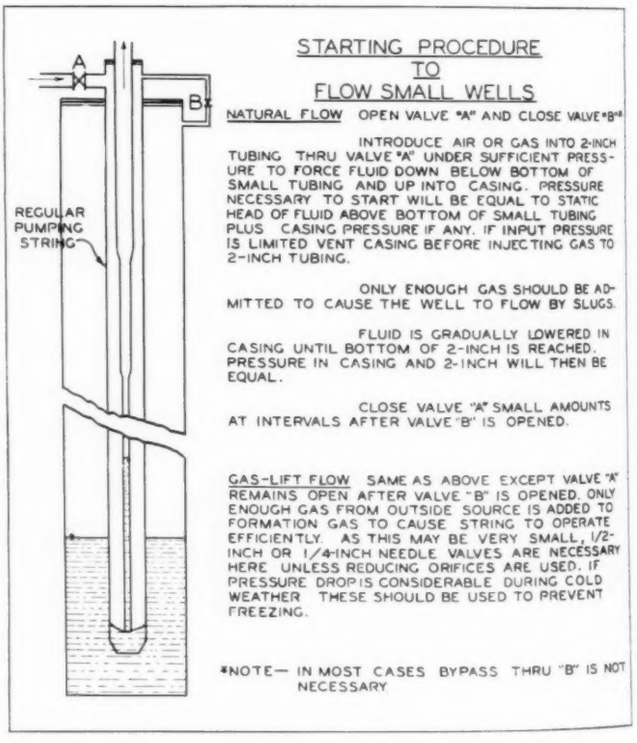
Sketch showing details of the hook-up now in use at most of the wells flowing through small tapered tubing.

Running the small tubing inside the two-inch caused no particular difficulty. The two-inch tubing in the well was not disturbed, but left hanging in the same position as when the well was pumping. It is set several feet off bottom with the top perforations of the anchor joint just above the top of the sand. The bottom of the tapered string is suspended just above the standing valve seat in the lower end of the two-inch. Long recessed couplings and steel swedge nipples are used on the tapered string and the time required to run it is about the same as for a string of sucker rods. In the accompanying sketches and photographs the latest improved type of hook-ups in use are shown. It will be noted that no packing is used, all joints are threaded or of the ground-joint flange type. On some of the first wells equipped for flowing the connection from the top of the flow string into the flow line was a long goose-neck of one-inch pipe. These are being discarded in favor of the improved type of hook-up in illustration, because during cold weather they become plugged with paraffin. On one or two wells it has been necessary in cold weather to pull and steam the upper 200 to 300 feet of tubing on the flow string because of paraffin trouble. All flow lines are two-inch, and two are almost half a mile long. The difference in elevation between one of these wells and the separator is eighty feet. During cold spells, the past winter, the oil in these lines would become so chilled that the back pressure on tubing-head at the well would increase from 15 pounds to 60 and 80 pounds per square inch. Even with this high back pressure on the tapered tubing the wells continued to flow, evidence attesting to the fact that the design of tapered tubing used is far from critical and can be depended on to operate over a reasonably wide range of pressure conditions in the well.

The tubing pressure and volume of gas produced, taken shortly after they were placed on natural flow, and the size and amount of tapered tubing used on thirteen wells are given in the accompanying table. It will be noted that the largest size tubing on the tapered string of two of the wells is only ¾-inch diameter.

Well	Two-inch tubing press. lb./sq. in.	Gas Vol. M Cu. Ft.	Lengths and size used in tapered string ⅜"	½"	¾"	1"
a	300	40			1680	820
b	230	30		620	1000	880
c	160	30			2000	500
d	200	15	1000	620	880	
e	225	30			1800	620
f	200	30			1900	600
g	150	35			1750	750
h	230	40			1500	1000
i	325	30			1880	620
j	170	40				2500
k	190	40			1500	1000
l	210	10	1400	440	620	
m	225	20	600	800	500	600

Operation of the wells is checked daily by the pumper, who, by means of a set of small pressure gauges which he carries with him, takes the pressure on the casing, two-inch tubing, and flow-tubing, respectively. He can immediately detect trouble in the well by pressure irregularities. The pressure readings are recorded on a printed form and sent into the office daily. The two-inch gas line that is connected into the casinghead and was in use for drawing off the gas to the casinghead gasoline plant on the lease when the wells were pumping has not been removed from any of the wells. A small needle valve has been inserted in this line just at casinghead and is used for feeding small quantities of gas into the two-inch tubing when a well "dies" or has "loaded up". One of the best wells in the whole group has been flowed continuously almost since tapered tubing was installed by feeding small quantities of gas into the two-inch tubing. This assistance could probably be dispensed with by installing a tapered string of another design. But as it was not desired to make this change a small amount of gas is bled into the two-inch tubing to keep the well flowing steadily. This is another illustration of the flexibility of the method. If the volume of gas produced by a well is insufficient to maintain a steady flow or high back pressure causes the well to flow by

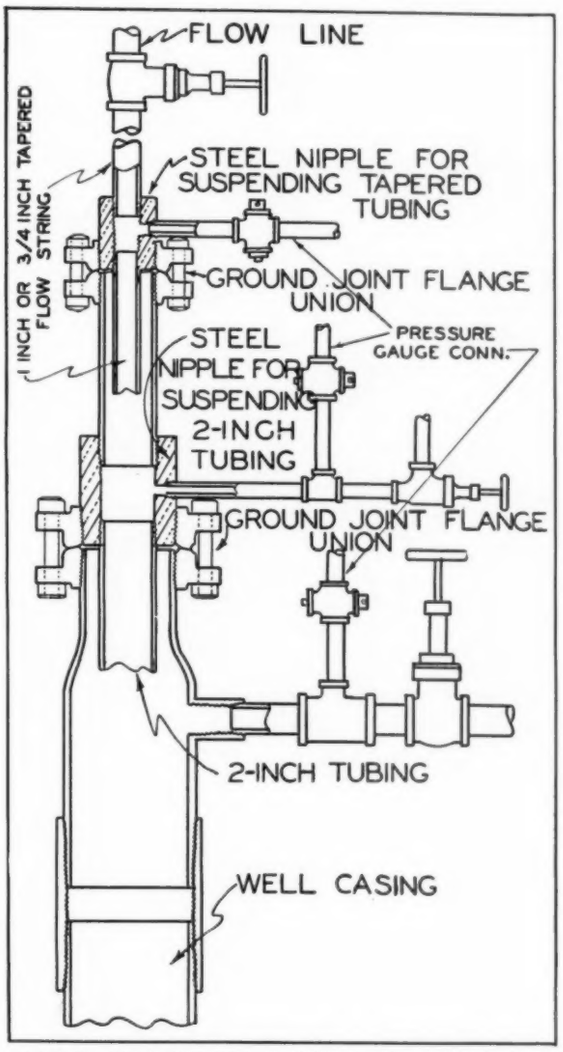

STARTING PROCEDURE
TO
FLOW SMALL WELLS
NATURAL FLOW OPEN VALVE "A" AND CLOSE VALVE "B"*
INTRODUCE AIR OR GAS INTO 2-INCH TUBING THRU VALVE "A" UNDER SUFFICIENT PRESSURE TO FORCE FLUID DOWN BELOW BOTTOM OF SMALL TUBING AND UP INTO CASING. PRESSURE NECESSARY TO START WILL BE EQUAL TO STATIC HEAD OF FLUID ABOVE BOTTOM OF SMALL TUBING PLUS CASING PRESSURE IF ANY. IF INPUT PRESSURE IS LIMITED VENT CASING BEFORE INJECTING GAS TO 2-INCH TUBING.
ONLY ENOUGH GAS SHOULD BE ADMITTED TO CAUSE THE WELL TO FLOW BY SLUGS.
FLUID IS GRADUALLY LOWERED IN CASING UNTIL BOTTOM OF 2-INCH IS REACHED. PRESSURE IN CASING AND 2-INCH WILL THEN BE EQUAL.
CLOSE VALVE "A" SMALL AMOUNTS AT INTERVALS AFTER VALVE "B" IS OPENED.
GAS-LIFT FLOW SAME AS ABOVE EXCEPT VALVE "A" REMAINS OPEN AFTER VALVE "B" IS OPENED. ONLY ENOUGH GAS FROM OUTSIDE SOURCE IS ADDED TO FORMATION GAS TO CAUSE STRING TO OPERATE EFFICIENTLY. AS THIS MAY BE VERY SMALL, 1/2-INCH OR 1/4-INCH NEEDLE VALVES ARE NECESSARY HERE UNLESS REDUCING ORIFICES ARE USED. IF PRESSURE DROP IS CONSIDERABLE DURING COLD WEATHER THESE SHOULD BE USED TO PREVENT FREEZING.
*NOTE— IN MOST CASES BYPASS THRU "B" IS NOT NECESSARY.
A
B
REGULAR PUMPING STRING

Instructions for starting flow of small wells.

"heads", the flow can be steadied by feeding a small quantity of gas into the two-inch tubing.

One of the wells is equipped with a packer on the bottom of the two-inch tubing to pack off between the tubing and casing. This well is sensitive to small pressure changes and "loads up" easily. By using a packer this trouble has been entirely eliminated and the flowing characteristics of the well vastly improved. Further, the well starts up easily without assistance after a shutdown. There seems to be ample evidence to incline to the belief that their universal use would be beneficial in maintaining steady flow in small wells of low gas pressure produced through small tapered tubing. These wells are producing from the Burgess sand, the uppermost member of what is known in the region as the Mississippi lime, and the gravity of the oil is 39 to 40 degrees A. P. I. Gas-oil ratios are by no means uniform, the lowest being about 800, the highest about 2000, and the average from 1000 to 1500 cubic feet per barrel oil. Even though the flowing efficiency may be low, these gas-oil ratios are, from the standpoint of cost of well operation, economical, for dry gas from the casinghead plant is used for repressuring. There is the cost of compressing this gas to about 500 pounds, but this cost is partly offset by the increased value of the gas produced with the oil due to enrichment of gasoline content. The average operating pressure of the wells is 15 pounds on the flow string and from 200 to 250 pounds on the two-inch tubing. In cold weather the pressure at the tubing head of the flow string may be much greater than this.

Save for one well that has a packer on the bottom of the tubing, almost all have to be given some artificial aid to start the flow. If the well pressure is not sufficient to unload the well, extraneous gas has to be supplied through the tubing. Some trouble was experienced at first in getting the wells started after a shutdown, so an instruction sheet was made up outlining the starting procedure to follow. The needle valve in the two-inch pipe through which the input gas is supplied to start the flow, has to be shut off gradually after the wells start flowing. If shut off too suddenly it is likely to "kill" the well. Also too much gas may depress the fluid level in the two-inch too low and prevent the oil from entering the flow string. The nature of the flow from the tapered tubing is a quiet, steady, continuous spray. Paraffin trouble in the flow lines has been


FLOW LINE
1 INCH OR 3/4 INCH TAPERED FLOW STRING
STEEL NIPPLE FOR SUSPENDING TAPERED TUBING
GROUND JOINT FLANGE UNION
STEEL NIPPLE FOR SUSPENDING 2-INCH TUBING
PRESSURE GAUGE CONN.
GROUND JOINT FLANGE UNION
2-INCH TUBING
WELL CASING

Sketch showing details of improved hook-up for gas-lift or natural flow through small tapered tubing, run in two-inch tubing.

the greatest trouble encountered in the operation of the wells, but this will be remedied to a great extent by changes in well and flow line connections.

It is modestly declared by those in charge that while the results thus far obtained have been satisfactory, it is yet too early to pass on the ultimate merits of small tapered tubing for small wells. It is known that operating costs have been reduced. Total lease costs over a long period will be necessary to get a true picture of the economies effected. Long-term results will best disclose the possibilities of the practice of flowing small wells through tapered tubing properly designed to meet the conditions. Even after discounting the fact that gas is being returned to the sand to maintain a uniform rock pressure, enough has been accomplished with this group of small wells to demonstrate the flexibility of tapered tubing and dispel the fear that frequent changes are necessary. If the design of flow string is based on an accurate knowledge of the reservoir and well conditions, a small well can be made to produce economically over a wide range of pressure conditions.

Hook-up at a well flowing through small tapered tubing run in two-inch tubing. The one-inch is connected into the two-inch flow line at the well head. Note the gauges for taking daily pressure readings.

Methods of

Treating High Octane Gasoline

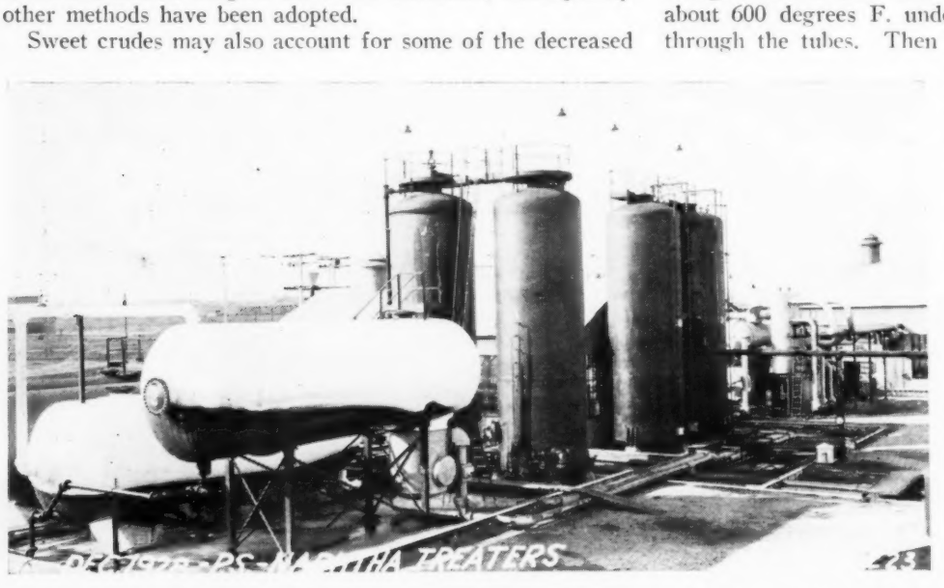
By F. R. STALEY

IN ORDER to retain all of the anti-knock value in a motor fuel, suitable treating methods must be used to refine it. Various processes are being used by refiners of high octane gasoline. The treating costs and the efficiency in removing gum-forming and corrosive sulphur compounds are important considerations. The problem is to remove all of the objectionable constituents at a minimum cost without reducing the anti-knock rating.

High octane gasoline is generally produced by cracking or by reforming. Steady improvement has been made in the art of cracking and in the design and construction of this type of equipment. The cracking capacities of American refineries have shown phenomenal growth in recent years, and this progress still continues.

While the petroleum refining industry is the second largest consumer of sulphuric acid in the country, during 1931 its consumption decreased 14.1 per cent over the previous year. This reduction was considerably greater than the corresponding decrease in crude oil charged to stills. There are a number of reasons why refiners are using less acid; first, because the percentage of sweet crude refined has greatly increased due principally to the enormous East Texas production, and, second, the fact that sulphuric acid reacts with valuable anti-knock compounds in the gasoline makes it an undesirable reagent for some distillates, consequently other methods have been adopted.

Sweet crudes may also account for some of the decreased consumption of litharge; however, refiners using plumbite solutions for sweetening usually regenerate the black strap by blowing with steam and air or by the use of chlorine gas, and also other chemicals are being more extensively used to sweeten gasoline.



Cold treating plant of the Standard Oil Company of California. The frost-covered tanks are used to settle acid sludge, the treaters are in the center, and the refrigeration equipment is visible in the background.

Bridgeman states that gum is the residue left on evaporation of gasoline, while resin separates from the liquid phase. Further, the formation of gum seems to be closely connected with oxidation processes, while resin appears to be formed as a result of polymerization due to catalytic action.

Some refiners treat the various fractions of their gasoline separately since certain fractions may require little or no chemical treatment. Investigations conducted by the United States Bureau of Mines at the Bartlesville Station indicate that proper fractionation will reduce the cost of manufacturing gasoline from high-sulphur petroleum by eliminating some of the treating costs.

The Gray Process is one of the most efficient methods of refining cracked or reformed gasoline. Since the demand for high octane gasoline has become so important many more Gray installations have been made. It can be used in connection with any cracking process to produce a non-gumming, colorless fuel with a knock rating at least as high as that of the raw cracked product.

A typical installation usually consists of two towers which are charged with Fuller's earth. The vapor can be passed through them either in series or in parallel. The diolefines and other gum-forming compounds are polymerized by the clay, and then are trapped out of the system. The last traces are separated in a small fractionating tower. Acid treatment is entirely eliminated by this process.

Gasoline produced by vapor phase cracking possesses high anti-knock properties, but it is a difficult problem to treat it efficiently. The Gyro Process Company has developed a process to treat cracked distillate in the vapor phase, using fine contact clay. The clay is fed into the liquid being charged into a tube still where the mixture is heated to about 600 degrees F. under pressure and at high velocity through the tubes. Then the pressure is reduced and the mixture enters a vaporizer where the polymers and clay separate and the gasoline vapors pass on to a fractionating tower. The clay and polymers are cooled and run through a filter press. The character of the distillate determines the amount of clay required and the time the mixture is maintained at the elevated temperature. A water white stable gasoline is produced. Although the process was designed especially to treat vapor phase cracked distillate it can be effectively applied to other distillates.

This also is a vapor phase process. Gasoline vapor is passed through boiling metallic salt solutions, usually zinc chloride is used. A stable gum-free gasoline is produced. Lachman states that the treatment with zinc chloride solution is best accomplished by an equipment which brings about intimate mixture of the gas and liquid phases at a temperature between 302 degrees F. and 347 degrees F., where the zinc chloride solution has a concentration ranging from 70 to 85 per cent, and at such a rate of passage that from two to twelve seconds are allowed for the process to complete itself.

The net consumption of zinc chloride is from 0.1 to 0.3 pounds per barrel treated. The recovery for reuse is simple. The discharged liquor is diluted with water to 50 or 60 per

cent and allowed to settle. A small amount of heavy oil on the surface is skimmed off for cracking stock. Most of the zinc chloride settles out as a heavy liquor which is used over again with or without reconcentration. The final emulsion is filtered on a continuous filter. The cake contains recoverable zinc, and is readily soluble in dilute hydrochloric acid.

A number of methods have been developed using sulphuric acid for treating cracked gasoline in such a manner that the reaction can be controlled better than by ordinary methods of contact.

The Standard Oil Company of California acid treats cracked distillate at reduced temperatures. By this means the anti-knock constituents are preserved. The refrigeration costs are quite low, and the acid consumption is reduced.

The Stratford Process uses a contactor to obtain intimate between the distillate and the acid. The distillate is then completely separated in centrifuges. The treating time is reduced to seconds, and the acid sludge is in contact with the oil for approximately thirty seconds only. The installation employs counterflow system. This is one of the most efficient methods of using sulphuric acid for treating. It is especially applicable to distillates high in sulphur content.

Gardner and Higgins recently presented a paper before the American Chemical Society on the uses of magnesium hydroxide in the petroleum industry. It is mined as the mineral Brucite.

The authors state that it is adaptable to four processes in the industry, as follows: phenol removal, hydrogen sulphide removal, neutralization of acidified stocks and the conversion of mercaptans to disulphides or sweetening.

Phenols are of particular importance in cracked gasolines. They have an undesirable odor, being acidic they are corrosive, and are believed to play a part in gum formation.

Results show that with a suspension of magnesium hydroxide large amounts of hydrogen sulphide can be rapidly removed from liquid or gaseous hydrocarbons, and that the base can be readily regenerated.

Granular magnesium hydroxide is applicable for neutralizing acidified stocks.

Sweetening gasoline with magnesium hydroxide was found to parallel plumbite sweetening exactly from the standpoint of sulphur balance. Magnesium basic mercaptides, gasoline soluble, are formed when a gasoline containing mercaptans is passed through a column of dry magnesium hydroxide; elementary sulphur reacts with these forming disulphides.

Commercially, two towers four feet in diameter and 20 feet high are connected in series. They are equipped with drying coils having a surface equivalent to about 25 square feet per ton of Brucite. Steam is used for heating. The Brucite is contained in the towers on perforated plates. The stock to be sweetened is pumped into the bottom of the tower, a portion is by-passed through a smaller receptacle containing roll sulphur where it picks up enough sulphur to complete the reaction.

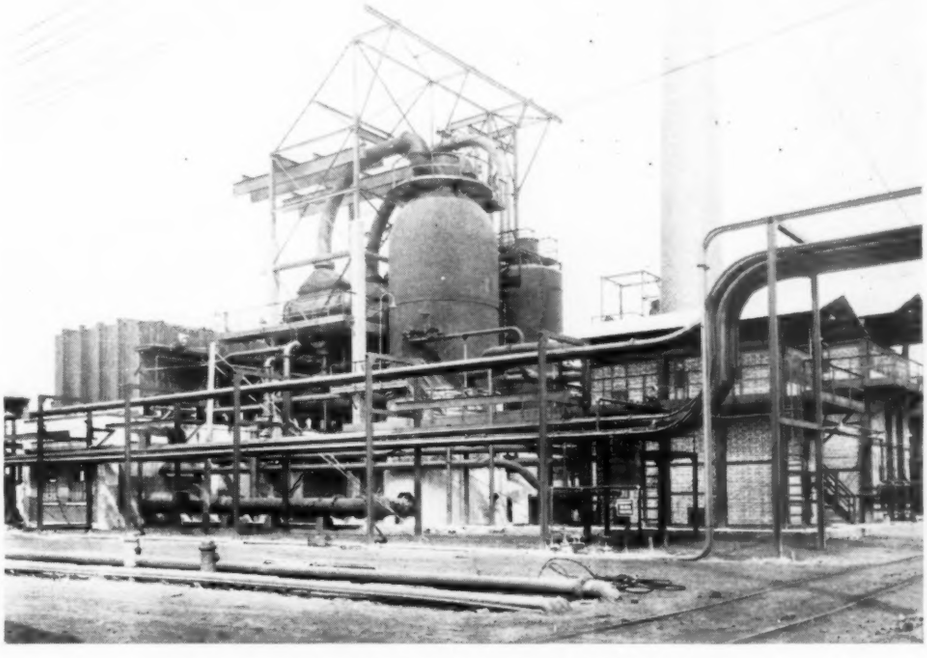
When the efflux becomes sour the gasoline in the columns is displaced with water, the base boiled with the water, followed by boiling with two per cent sodium hydroxide and washing twice with water, after which the washed material is dried in situ, and is ready for another cycle.

After being treated the gasoline is usually sweetened so it will pass the doctor test. Sodium plumbite is most extensively used for this purpose. The spent solution is usually regenerated which greatly reduces the cost.

Sodium or calcium hypochlorite is used for sweetening in many plants. According to Rue and Espach, if the product to be treated contains excessive amounts of free sulphur and is doctor sour the doctor method of treating usually gives better results than the hypochlorite.

Some refiners use ammonia copper sulphate or blue solution for sweetening. It is claimed to have certain advantages on some distillates.

Dr. Dunstan of the Anglo-Persian Oil Company has recently been granted a British patent for a method of deodorizing petroleum distillates. Certain oils containing organic sulphur compounds are not completely deodorized or sweetened with sodium plumbite treatment. Such oils are deodorized in a two-stage treatment, first with sodium plumbite, and then with chlorine or a chlorine compound such as sodium hypochlorite. Thus the mercaptans and sulphides are completely removed and the oil sweetened. Due to the relatively small proportion of the mercaptans and sulphides present only a small amount of sodium hypochlorite is required for the substantially complete sweetening of the oil.



A two-stage pressure distillate rerun unit in a Gulf Coast refinery.

Much progress has been made in the methods of producing and treating high octane gasolines. Many of the more important treating methods have been briefly outlined. Detailed descriptions of these various methods may be found in the literature. The most suitable method of treating a gasoline will depend upon its manufacturing process and the crude from which it originates.

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• • • • Mechanical Ingenuity *and* Practical Engineering Conquer Three-Year Roumanian Well Fire

By
WARREN L. BAKER

Entrance to Tunnel No. 3 (800 feet long) before explosion.

SKILLFUL application of practical mechanical ingenuity, ample usage of cement and rotary drilling mud, together with explosives, and advantages taken of caving banks of a gigantic crater have enabled M. M. Kinley, well-known oil well fire fighter and wild well capper, of Tulsa, Oklahoma, to successfully terminate the wild, uncontrolled flow and fire of the famous Societe Romana-Americana No. 160 well in the Moreni, Roumania, field.

The well resisted continuous efforts to subdue it since it caught fire on May 28, 1929. Many hundreds of thousands of dollars were spent in these attempts to control it, including expenditures for the construction of three long tunnels, drilling of two offset wells for the purpose of trying to circulate mud into the producing sand, building of a large blower suction plant, railroad lines and many other items. During endeavors to bring the flow under control a total of 14 lives were lost, the majority of which were claimed in the explosion of the tunnels. Because of such discouraging and disastrous results in the background of its history the belief grew that the well could not be brought under control.

Romana-Americana No. 160, probably the largest gas producer ever found in the world, was estimated to have had an initial production of 250,000,000 cubic feet of gas daily, expelled by a pressure of 2500 to 3000 pounds per square inch. The tremendous force of the pressure was sufficient to stall the slush pumps while they were laboring at a pressure of 1440 pounds per square inch in delivering 10 pounds per gallon mud and to blow 4750 feet of 6¾-inch drill pipe out of the hole and spread it over a large area.

When Kinley arrived to commence his battle against the elements that had previously defied man and his inventions, he found the loose formations surrounding the well had cratered, until it nestled in a hole 250 feet in diameter and 65 feet deep. Two of the tunnels had exploded, the top joints of the 14-inch casing string were cut away by sand and gravel expelled with the gas; and winter approaching with its accompanying rains and snows and the well making just enough oil with the gas to make work terribly greasy and disagreeable. The only encouraging factor was the weakened pressure and output of the well, due to its prolonged open flow.

The crater was comprised of two cavities, the inner cavity, much smaller in diameter and very steep as compared to the outer gorge, encircled the area immediately around the well and started about 25 feet below the surface. The top of the inner hole was marked by a shelf or ledge, from which the men did much of their work. The destruction of the top joints of the 14-inch pipe to a point about 15 to 20 feet below the bottom of the pit greatly increased the difficulties and probabilities of quickly capping the well as this condition made it impossible to attach flow connection onto the outlet string.

The tremendous task of overcoming these obstacles before placing the well under control is best shown by Mr. Kinley's diary. The diary shows seven months passed from the time Kinley commenced work on August 3, 1931, until the output was turned into gas lines on February 7, 1932. Grady Chupp, an American, who was formerly assistant drilling superintendent for the Societe Romana-Americana company in the Ploesti field, served as assistant to Kinley during the entire fight. The two men with the aid of a Roumanian, Costica Lupa, did all the work accomplished within the crater; the government permitting only three men to enter the hole.

After spending several days doing preliminary work, which consisted of installing steam and water lines, the well was shot twice with 50 kilograms of 90 per cent gelatin, the last explosion smothered the flames for a few minutes on August 10th. It was then decided to bring the flames into a concentrated position, previously they had been spread out fan-shape, and to remove them from their proximity to the mass of red-hot steel wreckage, sufficiently heated to cause re-ignition, lying around the well head. Concentration of the flames was accomplished by construction of a 35-foot height sheet-metal stack of 18-inch diameter, lightweight pipe, which projected from a funnel-shaped base. This device was placed over the flame by sliding it down the side of the cavity and raising it upright into position with the use of a tractor. The large funnel base trapped the flames as they leaped from the mouth of the well and ex-

pelled them in a single column at the top of the stack. By swinging explosives over the top of the stack, achieved by stringing a cable across the crater, the well was shot twice without effect, probably due largely to difficulties of properly locating the shots by this method. However, the second shot broke one of the guy wires, permitting the stack to fall over. Because of this accident and the difficulty of accurately placing a shot suspended on a cable, other plans for combating the fire were made.

After putting out numerous small fires jetting forth from the walls of the crater the men were able to work in the pit, which permitted them to fish out considerable steel junk from around the mouth of the well. They also deepened the crater, concentrating the flames in a more centralized location. The next step taken, having failed at the well, was to rig up a blower at the entrance to tunnel No. 1, which undertaking was somewhat more successful than previous attempts in that the flow from the mouth of the well was reduced. Before the blower or suction machine could be rigged up it was necessary to clean out the tunnel, including extraction of a string of four-inch drill pipe left in the tunnel by other workers. This later proved a most vital operation, as clearance of the tunnel finally allowed the well to be successfully controlled. When the drill pipe string had been pulled out a 10-inch string of casing running through the tunnel to a point below the mouth of the well was left clear and the suction blower was attached to this pipe. When the blower was started it drew off a sufficient portion of the gas, expelled it into the air at the tunnel entrance, to reduce the flame about 50 per cent.

While cooling off the banks of the crater, preparatory to shooting the well again, the water placed in the crater, together with recent rains, so softened the banks that they caved in, putting out the fire. This was a very important discovery as the knowledge gained permitted the men to extinguish the flames with comparative ease whenever it caught fire again. The caving in of the banks had previously occurred at various intervals without affecting the well, but because of the outlet through the suction blower and the resulting reduced flow at the well mouth the pressure was not sufficient to withstand the landslide.

The pit of the crater by this time was filled with water and mud, which the gas intermittently broke through, and while extracting this fluid mixture the well caught fire again from the ejector (September 28th). An attempt was then made to lubricate the well with water through tunnel No. 3, which tapped the casing 250 feet below the top of the hole, and later 400 sacks of cement were poured through the third tunnel in attempts to seal up the producing horizon, but evidently these fluids did not reach the desired destination as no effect on the flow of the well resulted.

Since the best results had been obtained through the first tunnel it was decided to make another attempt to divert the entire flow through this tunnel, for which purpose a special device in the form of an expansion bit, having a butterfly type valve at the end, was constructed. The butterflies, or clappers, were expected to spread out and upward when the gas pressure hit them and in this manner seal off the 14-inch casing at the top of the 10-inch pipe connection (see figures 1 and 2), and thus direct the gas flow through the pipe outlet in the tunnel. The expansion bit was run through the 10-inch tunnel pipe by attaching it to the end of a string of 8-inch pipe. When the bit penetrated the 14-inch flow casing some obstruction prevented both clappers from fully opening, but approximately a 50 per cent reduction in the size of the flow at the well mouth was noticeable.

Since 75 per cent of the original flow, including that drawn off the suction blower and that diverted through the tunnel by the expansion bit, was now going through the tunnel, the size of the well was materially smaller and this

Early view of well. Note: twisted steel wreckage which later caved into the crater as it was formed.

encouragement caused the fire fighters to again direct their attention to capping the well at the well head. Explosives placed in the walls of the crater caused the banks to hydraulic, again snuffing out the flame. After extracting water and mud for several days, considerable time was devoted to removing twisted particles of the rotary drilling machinery, but while using explosives to loosen these pieces of equipment the gas was ignited from one of the shots on November 1st, but again the fire was extinguished by caving in the banks and the men returned to the work of removing water, mud and junk from the pit. Practically all of the steel wreckage was removed at the end of a week, including such equipment as a rotary slush pump, a crown block, a rotary table and much pipe, but the drilling engine was never located. To expedite removal of earth and debris from the crater a small tramway had been built and was the principal means of extracting material from the hole. The crater, at this time, was deepened around the well in hopes of locating the top of the 14-inch casing, but anticipations of finding it were given up, apparently it was 15 to 20 feet below the bottom of the pit.

Some obstruction was apparently over the top of the pipe as the gas flow was spread out in a fan-shape, about six feet across, so it was decided to again try the funnel and stack device; however, a new one of much heavier material was constructed. The funnel, or hood, was made of boiler plates and measured 8 x 8 feet, while the stack was made of 12½-foot diameter pipe 15 feet in length, connected to the funnel by a two-foot nipple. This funnel was placed over the flame on November 26th and preparations for cementing it into place were made and carried out during the next several weeks.

This cementing operation was composed of pouring 10

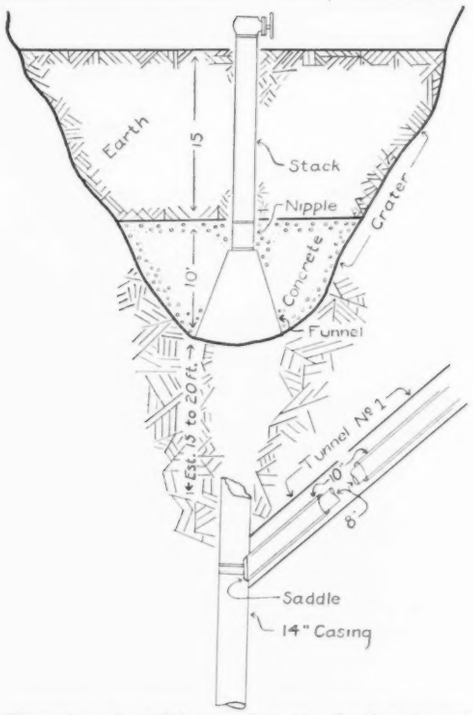


Illustration of conditions at the well. See how the top of the 14-inch casing has been cut away and how tunnel No. 1 tapped this string of pipe. The drawing also shows lower portion of the crater with funnel device, by which means the well was capped through injection of cement, in place.

feet of cement in the bottom of the crater for the aim of congealing the hood in place. Later, earth was placed on top of the concrete until a total of 25 feet of material had been deposited in the hole. This lay-out proved sufficient to hold the hood in place and there followed a total of six cementing operations, carrying hopes of solidly congealing off the open space between the 14-inch casing and the funnel. A precaution taken before completing this work was to cement the annular space between the eight and 10-inch pipes in the tunnel, so they could withstand the full force exerted by the well should it successfully be diverted through this channel.

When cement in the tunnel had set, three cars of cement were poured through the stack without results, but an additional carload caused it to break through to the surface by channeling around the huge concrete block and through the earth fill on top of the block. This necessitated placing more dirt on top of the concrete base.

Since it was not desired, at this stage, to permit the cement within the stack and funnel to harden solid (it being necessary that the space between the pipe and hood be properly cemented before filling up the device), because this would have made it impossible to again inject cement through the stack, the valve on top of the projecting upright pipe was frequently opened; the pressure of the well blew out the cement within the stack at such times (it held 135 sacks). Later, in order to leave a portion of the cement within the hood and stack a three-inch outlet was placed on the stack and a part of the gas taken off in this manner.

After 700 sacks of cement had been used in this fashion very little gas was leaking around the crater; however, circulation had not been established between the mouth of the well and the tunnel and which was necessary to assure a perfect cement job that would accomplish the desired effect of shutting off the top part of the 14-inch casing and sending all the flow out the tunnel.

Finally despairing of hopes to successfully establish cement circulation a big dose of heavy rotary mud was substituted. Upon the injection of this fluid all the channels in the soft formations surrounding the well were sealed off and circulation secured by the flow going down the stack, entering the 14-inch casing and the returns coming out the tunnel eight-inch pipe. Cement circulation was then an easy matter and was followed by a cement job of 250 sacks, which was allowed to harden.

When the three-inch outlet on top of the stack was opened no gas escaped, the entire flow continuing to go through the eight-inch within the tunnel, illustrating that the job had been successful; the cement evidently setting solid and completely between the hood and the 14-inch pipe. But, when the entire gas flow was directed through tunnel No. 1, the pressure blew out the cement between the eight and 10-inch pipes, so, on January 28, 1932, this cement job was again performed.

All of the work which followed consisted of preparing the well for production by connecting up the tunnel flow line. The first step was the construction of a split joint of pipe, in the shape of a Y, one end of which rose vertically into the air and the other laid on the ground. This designed hook-up was attached to the end of the eight-inch pipe at the mouth of the tunnel, and while the gas was discharged through the vertical branch of the pipe the other was connected up with four oil and gas separators. After these connections had been made and the separators, in turn, connected to a nearby gas line the flow was turned into the separators by closing the vertical line and opening the horizontal one. This operation was completed at noon, February 7, 1932, and at that time the well produced its first output into the company lines, although it had been two years and eight months previous when it blew itself in.

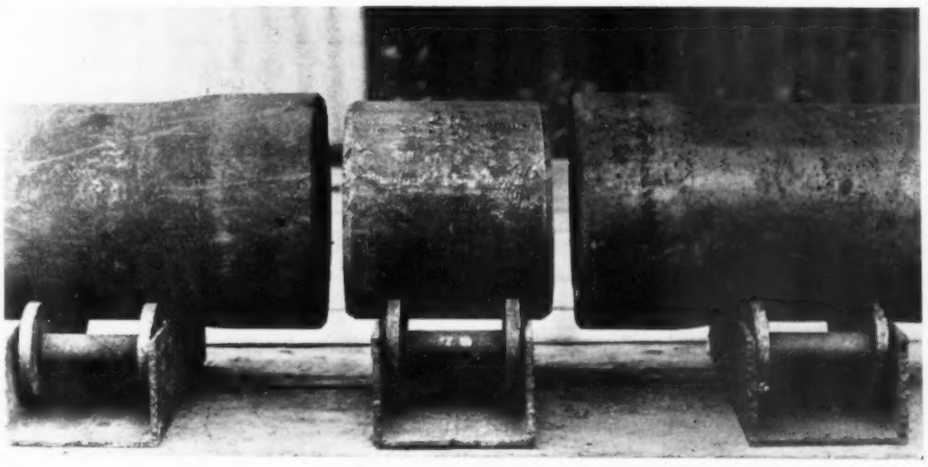
The outside crater and first funnel-stack device. Note: inner crater is not visible.

Construction Costs Lowered by

CLOSE INSPECTION *of* WELDING

By J. H. DAMERON

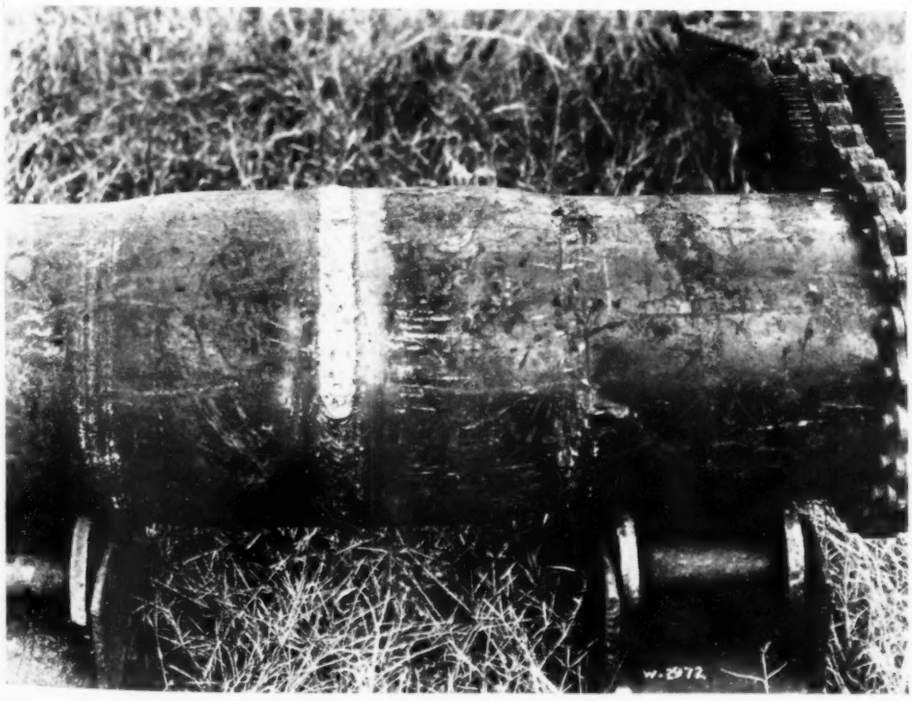
IN THE present era of welding construction, records of perfect and near perfect work are frequent, but occasionally one stands out prominently. Such a record was recently established by the Gulf Pipe Line Co. of Oklahoma in the building of 40 miles of eight-inch line. The line was electric welded by welders who had little or no experience in pipe line welding and not a single leak developed when the line was initially tested with oil at 825 pounds pressure. Since then it has given service without any trouble developing.



Detail of typical welded point showing finished weld and position of dollies.

This line is an eight-inch oil carrier running from Perryman station near Jenks, Okla., to Grayson station near Henryetta, Okla. It was built entirely by company employes, most of whom would have been laid off during a slack period or had their work prorated. In order to employ as many men as possible, all of the ditching was done by hand. Despite the prevailing inclement weather at the time, the welding was completed in about 21 days and the entire job completed in less than 30 days.

One of the interesting features connected with the construction was the welding procedure employed. The shielded arc method of welding was used for both the firing line and bell hole welds. The pipe was random 40-foot plus, double bell end lengths weighing 28.55 pounds per foot with a wall thickness of .322 inch. The back-up rings were made by cutting the plain ends off the long lengths of pipe before the ends were belled out. They were cut to a length of about seven inches and beveled on both ends for the dual purpose of permitting them to slide more readily in the bell ends of the pipe when it was lined up and also to offer less resistance to flow through the line. No particular effort was made to obtain welding speed during construction, but close attention was given to obtain good welds. Most of the welders had no experience in pipe line welding. They did have, however, considerable experience in electric welding in shops, tank farms and at stations. These men were given a short course of instruction and sent out to the firing line, while the more experienced welders were used to make the bell hole welds.



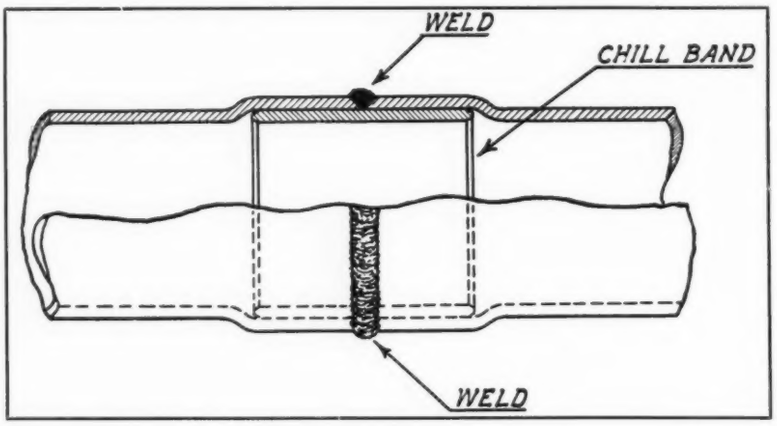
Cross section of beveled joint showing beveled chill band position in double bell pipe.

On the firing line the pipe was lined up in sections containing anywhere from five to 13 lengths, depending on the nature of the terrain. All of the pipe was lined up on dollies identical to those illustrated. These were made with angle iron with the rollers set near the two ends. The rollers were made by cutting circular discs from boiler plate.

Two dollies were usually placed under the two end lengths

of a section and only one under the lengths inside the section. The dollies were placed anywhere under the inside lengths from a point close to the belled end of the pipe to as far as 10 or 12 feet back.

Six men and a tractor comprised the line-up crew. The tractor was used to pick up the pipe and bring it into position for stabbing the back-up ring in position. In order that the beveled ends of the pipe might be spaced more uniformly a spacer ring was used in the line-up work. Just before the pipe ends were brought together the ring was inserted to keep the two ends spaced about $\frac{3}{16}$ of an inch apart. The rollers were placed on skids whenever necessary to bring it in an approximately straight line. When the pipe was properly spaced and in alignment it was tack welded to hold it in place for the firing line weld. Two tack welds were usually made, one on each side of the pipe, and each weld was about an inch to 1½ inches long.



A firing line welding crew was comprised of one welder and a helper to each gasoline engine-powered generating machine. The helper attended the generator, placed the welding rods and cleaned each of the welds made by his welder. Attached to each crew were helpers to turn the pipe with chain tongs during the roll welds.

A $\frac{3}{16}$-inch welding rod was used to make the first bead. The burning-in bead fuses to the pipe and back-up ring and is made as the pipe is slowly rotated. Upon completion of the weld the helper used a hooked and sharpened tool to clean the scale deposit from the weld. The latter forms as the weld progresses. It flows from the rod as it is melted and its purpose is to prevent oxidation during welding. After the scale was scraped the weld was cleaned to a bright finish with a wire brush. This was done to permit close inspection and to insure proper fusion of the finishing bead.

The finishing bead was made in identically the same manner as the burning-in bead except that a one-quarter-inch rod was used. The finishing welds were usually flush with the pipe or slightly higher. These welds were scraped and brushed to permit close inspection. Each weld was inspected for neatness in workmanship and to determine how the finish of the weld lapped over the starting point. During both the burning-in weld and the finishing weld the generating machine was operated at 300 amperes. A complete firing line weld required approximately 1½ pounds of welding rod. Each welder usually turned in between 45 and 50 firing line welds daily.

Bell hole welding consumed twice to three times as much time as a firing line weld because of the difference of welding procedure. The amperage of the generator was cut down to 200 to 250 amperes so the work could be carried on more slowly when the welder was working on the bottom half of the joint. With the lower amperage the rod melted more slowly and the molten material fused with the parent metal and cooled more rapidly.

The sections of pipe were lined up with the aid of tractors and the free ends of pipe were spaced about $\frac{3}{16}$ of an inch apart before being tack welded. The tie-in welder made each bead by working the welding rod back and forth across the vee. In making these welds it was practice to start at the bottom of the joint and weld around the pipe as far as the welder could reach. This was usually half way up the side being welded. The welder then changed positions and welded the same distance on the other side of the pipe. With the most difficult half welded the welder completed the comparatively easy top half of the weld.

When the welding was completed those in charge of the work felt certain that each weld had been perfect. For that reason it was decided to test with oil rather than with water or air. The line was cut into main line service and the pressure built up to 825 pounds. The pressure was held at that point for a few hours without a drop, indicating no leaks in the line. Since that time the line has been in service without any leaks developing.

Because it was desired to give as many men employment as possible the pipe line company did not use any of its ditching machines. Instead crews were employed and paid on a footage basis to dig the trench by hand. The scale was arranged so the men could earn from $4 to $6 daily. Originally the specifications called for a trench 24 inches deep, although one 22 inches was all the depth desired. The extra depth was suggested to insure getting a ditch 22 inches deep. The first few days, however, indicated no trouble would be experienced in getting a ditch 22 inches deep because all of the ditch was measuring 24 inches or better. The orders were then changed, requiring the crews to dig 22 inches deep and even then the crews dug their trenches a little deeper than the required depth. Most of the ditching was comparatively easy because the ground had been softened by frequent rains. About five miles of the right-of-way was through rocky country that made it necessary to use blasting material. The back-filling was done with machine and by hand.

Because of the prevailing bad weather during the construction period, stringing the pipe was at times difficult. Operations were carried on from Jenks and Okmulgee and trucks would haul the pipe out to the nearest points to the right-of-way. Teams were then used to "snake" the pipe on in to the job.

All of the bends made were cold bends and made with the aid of tractors. Usually one tractor was used to weight down the pipe at the point of the bend while the other tractor was used to pull a bend in the pipe.

While no particular effort was made to attain speed in welding, the welding progressed fairly rapidly. The welding averaged about two miles per day despite the bad weather which slowed operations. But with the use of the back-up ring, lining-up was speedier and welding progressed satisfactorily. Of more importance, the job was completed without any leaks developing, entailing the added cost of sending crews out for repairs.

Controlling Gravity *and* Preparing Crude *for* Pipe Line Requirements

By CHARLES P. BUCK,
Consulting Engineer, Topeka, Kansas

WHEN, years ago, the posted price for crude oil based on gravity appeared, the booming demand for motor fuel was met by refiners who produced it by simple straight-run distillation. Crude oil, consequently, was worth to them what it contained of straight-run gasoline and therefore premiums were gradually established for crudes high in volatile fractions.

A noteworthy development of present-day petroleum practice is the very great advance of the natural gasoline industry. So great a factor is natural gasoline in the market that it already provides a surplus over the blending demand which formerly was its sole market and a direct market for special grades of stabilized and treated natural gasolines has been found. The great growth in the distribution of liquefied petroleum gases—butanes and propanes—is ample evidence of the manner in which the natural gasoline manufacturer is converting wasteful by-products into sources of revenue. Liquefied gases are just one of the many by-products of the modern natural gasoline plant.

Natural gasoline has proved itself an anti-knock motor fuel of high value. The natural gasoline industry has made technical and economic progress of an exceptionally high order and has developed processes which entitle it to a much broader market within the scope of its peculiarly desirable possibilities. Not the least of these is its strong economic position in respect of the costs of manufacture. The natural gasoline industry, existing solely through its recovery of otherwise wasted raw material, can be expanded still further to utilize the gasoline fractions that are a nuisance to the refiner and, as well, treat and blend those fractions to a complete anti-knock fuel. This requires only a thorough grasp and complete acceptance of the fundamentals of the problem of high-gravity crudes which now confronts producer and refiner alike.

The practical solution of the problem consists wholly in the complete removal of the troublesome impurities and wasteful fractions on the lease, before the crude is delivered to the pipe line company. When this is accomplished the whole industry gains. The refiner pays for, and gets, the crude that is most profitable to him. The natural gasoline manufacturer becomes an individual entity, no longer dependent on a secondary market for blending material, but a purveyor of a finished product. The pipe line company avoids evaporation shrinkage and expensive recovery of "tank bottoms". The producer gains because he markets, in definite, measurable form, the entire production of his properties. The whole industry thus brings itself into step with the plainly marked trend of market demand, and of the high efficiency essential to continued profit.

There are many factors in present-day petroleum production which all contribute to the economic soundness of the suggested practice. The shallow sands have been pretty well drilled up. Others will, from time to time, be discovered, but an increasing proportion of the flush production of today comes from horizons deemed wholly impractical but a few short years ago. Crude oil from the deeper sands carries substantially greater volumes of dissolved gases, due to the great pressures under which oil and gas co-exist in the deeper horizons. There are greater and more stubborn problems to be met with in "cut" oil, because of the release of gas under such tremendous pressures in the presence of oil and water. The crude is of a higher gravity—carries a greater proportion of the low-boiling gasoline fractions. Possibly no recent fields have developed more advanced methods than have Oklahoma City and Kettleman Hills, which may be accepted as the type fields of future deep drilling production. The development of advanced production practice in these fields marks a greater general application of sound engineering to all phases of oil production than any previous period of like duration. There is now a wealth of data on all the problems involved. Individually, most of these problems have found effective solutions.

To prepare this oil from deep wells for pipe line acceptance—to eliminate the dissolved gases; to wholly remove all water, asphaltic precipitates and colloidal earths, restore the waxes to complete solution, and thus effect complete recovery of emulsified oil; to remove and recover the lower-boiling gasoline fractions in such degree that a clean, stable crude of desired gravity is delivered for transportation and refining—this can all be economically made by one fully-controlled operation. It is needed but to combine in one unit and under one control on the lease what is already being done under more or less casual and unrelated circumstances in three or four separate processes of dehydration, possible degasification, vapor recovery, and recovery of "tank bottoms"—all generally carried out in a wholly mistaken belief that all the gasoline fractions from the well must be crowded back into and retained in the crude from which they so persistently and strenuously endeavor to escape.

Start at the well-head and follow the crude through to the pipe line.

Getting rid of high-pressure natural gas is the first of the series of problems to be met. It is a great boon to the producer that natural gas is being so widely distributed as fuel, domestic and industrial. The vast network of natural gas distributing systems, now growing so rapidly and served by a system of gathering lines reaching almost every major field, assures a wide and stable market for all the natural gas not required for the most efficient operation of producing properties.

Present practice in the separation of gas from oil has been so well described that there is no need herein of any extended description of practice or equipment. The gas, if from high-pressure wells, separated at 40 to 50 atmospheres, carries so little of the low-boiling gasoline fractions that it is ready for the natural gas pipe line without further treatment. At the same time, most of the free water or brine (as distinguished from emulsion) is removed. From the high-pressure stage of separation the crude passes to the low-pressure separator, where pressure is reduced to slightly above atmosphere. Reducing the pressure allows some of

the dissolved gases to leave the crude but, actually, comparatively little of the disturbing portion of it so escapes. Dissolved gas is stubbornly tenacious of its association with oil. Observation of oil in carelessly constructed or carelessly maintained storage, discloses that gas escapes from the crude over long periods of time—a year or more—at surprisingly uniform rates, conducive to a high ratio of evaporation loss. There is, however, practically no loss of valuable fractions if the gas vapors removed from the oil in the low-pressure separator are passed through the natural gasoline plant.

It is after the crude leaves the low-pressure separator that dehydration is usually attempted. "Cut" oil has long been a problem for the producer to solve. The pipe line has placed arbitrary limits on the maximum amount of B. S. which will be accepted in oil offered for pipe line delivery. It is this accepted inclusion of B. S. which accumulates in gathering, relay and storage tanks to form "tank bottoms"—a loss of good, heavy fractions as well as a source of trouble and expense in cleaning tanks. The treatment of "cut" oil has also been the subject of numerous excellent articles in the columns of this journal, so that reference to existing practice will be readily grasped.

B. S., however, is usually more than merely "cut" oil. It includes asphaltic or naphthenic matter, or waxy material which has settled out of the oil due to the refrigeration effect of gas escaping, or dissolving out, from the oil under conditions of great reduction of pressure, as at the bottom of the well. Such material occurs, usually, in association with the colloidal or soapy earths that under other circumstances would produce a much simpler precipitate or emulsion.

There is one sovereign effective means of treating such stubborn emulsions; that is, sufficient heat to vaporize the water of emulsion and to reduce the viscosity of the waxes to a point where they may again be dissolved in the crude. This degree of heat, in an open tank or system, inevitably causes a serious loss of the gasoline fractions which make high gravity. Consequently practice in dehydration has tended more and more to electricity and especially to the use of chemicals which assist in breaking up the globules of water in the emulsion and so cause the water to coalesce and settle out of the crude. Such treatment, aided by heat, assists in restoring the waxes to the oil.

Heat is valuable in another direction. That is, in driving off the dissolved gases. That heat is an effective agent for this purpose is apparent to any operator of a compression casinghead gasoline plant who has attempted to recover the vapors from a steaming tank where oil is being dehydrated. The condensate from such vapors is about as "wild" as anything that could be imagined. These released dissolved gases belong back in the well, in repressuring and gas-lift operations. They should be removed from the crude on the lease, where they can be used to greatest advantage.

Actually, the preparation of crude oil for pipe line acceptance should serve to retain in it all those deliverable fractions of most value to the refiner; remove the asphaltic, naphthenic and colloidal residues; remove the "fixed" gases that, over long periods of time in storage, tend to escape, carrying with them valuable gasoline fractions, and do this in a manner that in greatest degree conserves the residual by-products of the well and also the labor involved in operation, the investment in equipment, and the producing life of the property.

The efficient solution of this problem lies in combining dehydration, degasification, and stripping and stabilization of the crude.

Figure 1 shows diagrammatically how this may be accomplished. Fluid from trap or surge tank enters the system as shown. Chemical has been used to free the crude of as much water as possible before it enters the system for treatment, thus reducing the volume of fluid to be heated. The raw fluid passes through a heat exchanger, taking up heat from the finished crude and cooling it for pipe line delivery or storage. Thence the raw fluid passes to a wash tank where the partially heated crude is washed through several feet of water maintained at about 200 degrees F., thus freeing the waxes, removing asphaltic precipitates, colloidal earths, etc., and freeing the oil of any residual emulsion. The washed oil flows thence to a pre-heater where it is brought to 260 degrees F. or more, and thence into a stripping column which is essentially a plate still. Above the stripping column is a fractionating column, of which reflux and temperature controls are such as to provide the necessary flexibility of control of the head products. Side streams provide means of taking off heavier cuts of such gravity as is desired to blend with the product of the natural gasoline plant to make a finished motor fuel. In the kettle of the stripping column are steam coils and means of injection of free steam. Control of temperatures in pre-heater, kettle and of reflux makes it possible to take off such fractions as will make the finished crude of a uniform gravity. The system is wholly a closed system, from casing head to pipe line, which insures recovery of all products of value.

The operation of this system accomplishes these things:

It removes all sedimentary impurities from the crude.

It returns the cleaned waxes to solution in the oil.

It removes all "fixed" gases from the crude, and stabilizes the prepared oil to a predetermined gravity.

It can be so controlled as to deliver to the natural gasoline plant such a cut from the crude as will supply the heavier fractions to blend with natural gasoline to make a complete anti-knock finished motor fuel.

It delivers to compressor intake clean gas for well operation, thus conserving natural gas produced for sale to natural gas distributing companies.

It centralizes the whole operation of conditioning the crude for pipe line acceptance in one unit, conserves in highest degree the fuel and labor required for operation, and with proper recording meters, provides a complete and continuous graphic record of the entire production of the property.

Obviously such a combined unit is for the property of relatively large production, or for the field in which operators co-operate whole-heartedly in uniform practices to the end that they may realize the maximum financial return from their properties. More than half the production of the United States is derived from small wells or closely subdivided properties. In these cases, where there is a large degree of co-operation among the operators, the same principles may be applied to the production from small wells and small properties, delivering a crude from which most of the dissolved gas, B. S., and a considerable part of the gasoline fractions have been removed and salvaged.

The oil producer is essentially a miner, but a miner who produces a raw material of infinite complexity whose every constituent is of real financial value. The miner of gold or silver or copper who, in the preparation of his ore for the smelter, leaves in the tailings a part of his valuable ore can rework his dump and recover the value he originally lost. It is not so with the oil producer. He cannot rework his tailings dump. Whatever he fails to recover and sell in the first working of his crude is gone—irrevocably lost. The practice herein suggested not only enables him to realize on all the value of his production to the greatest efficiency of his property—all the gas and gasoline vapors as well as the heavier and more stable fractions—it enables him as well to so prepare each part of it as to give each part its greatest value in the market.

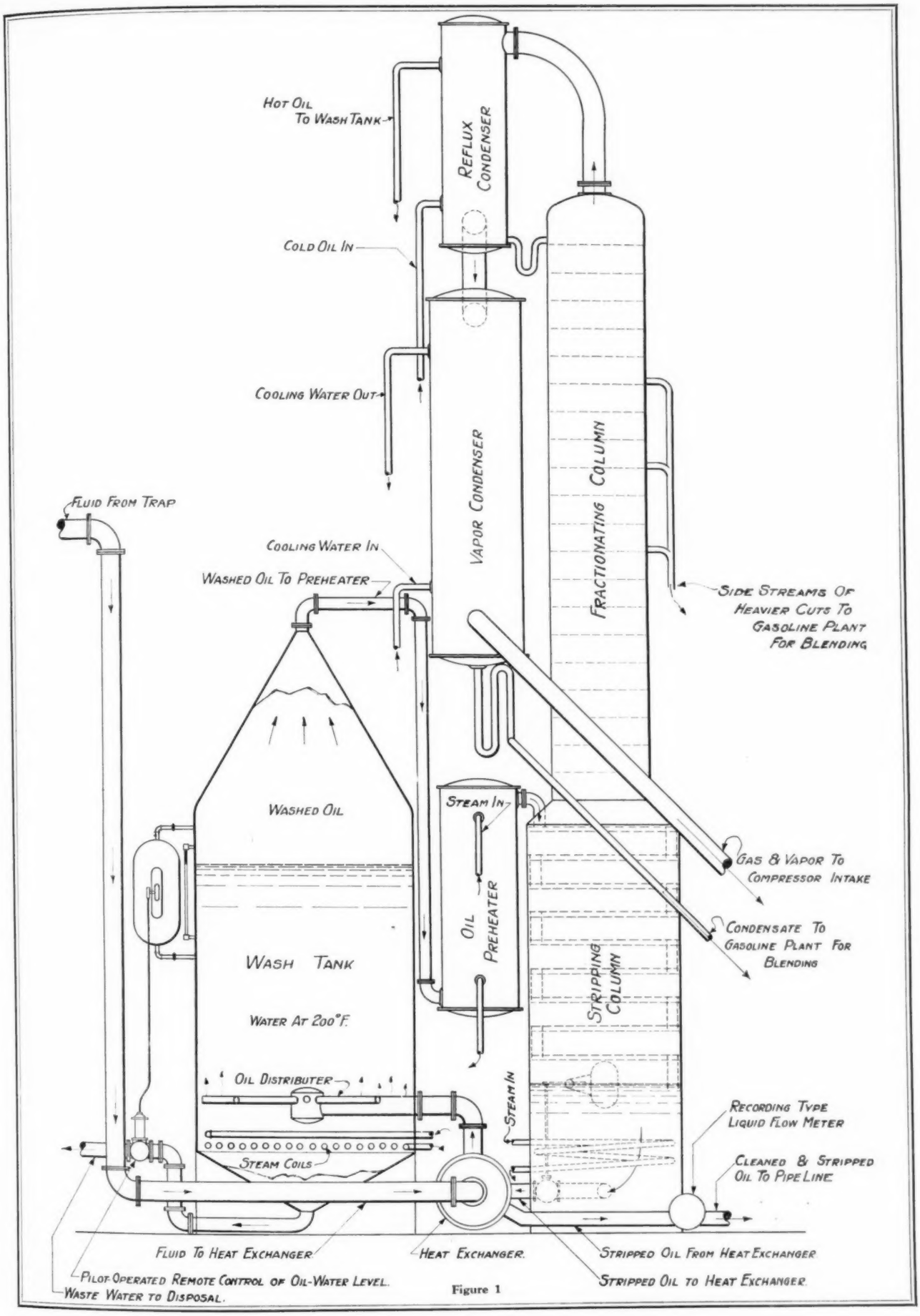

HOT OIL TO WASH TANK
REFLUX CONDENSER
COLD OIL IN
COOLING WATER OUT
VAPOR CONDENSER
FRACTIONATING COLUMN
FLUID FROM TRAP
COOLING WATER IN
WASHED OIL TO PREHEATER
SIDE STREAMS OF HEAVIER CUTS TO GASOLINE PLANT FOR BLENDING
WASHED OIL
STEAM IN
GAS & VAPOR TO COMPRESSOR INTAKE
OIL PREHEATER
CONDENSATE TO GASOLINE PLANT FOR BLENDING
WASH TANK
WATER AT 200°F.
STRIPPING COLUMN
OIL DISTRIBUTER
STEAM IN
RECORDING TYPE LIQUID FLOW METER
STEAM COILS
CLEANED & STRIPPED OIL TO PIPE LINE
FLUID TO HEAT EXCHANGER
HEAT EXCHANGER
STRIPPED OIL FROM HEAT EXCHANGER
PILOT-OPERATED REMOTE CONTROL OF OIL-WATER LEVEL.
STRIPPED OIL TO HEAT EXCHANGER
WASTE WATER TO DISPOSAL.

Figure 1

An Interesting

Plugging Back Job Completed With New Tool

A VERY interesting job of plugging back an old deep well to an upper producing sand has recently been completed in the Greater Seminole, Oklahoma, district. The mechanical operations in performing this function consisted of a combination of plugging back, whipstocking and round reaming, the result of this work was an entirely new perforation into the shallower producing sand, although less than 300 feet of fresh hole was actually drilled. This was accomplished by the use of a specially designed tool, developed and manufactured by the Hinderliter Tool Company, Tulsa, Okla. The principal feature of the accomplishment was the work of the special tool which cut an outlet in the eight-inch casing sufficiently large to eliminate any difficulty in landing the new seven-inch O. D. casing string through the opening, and to the top of the producing sand.

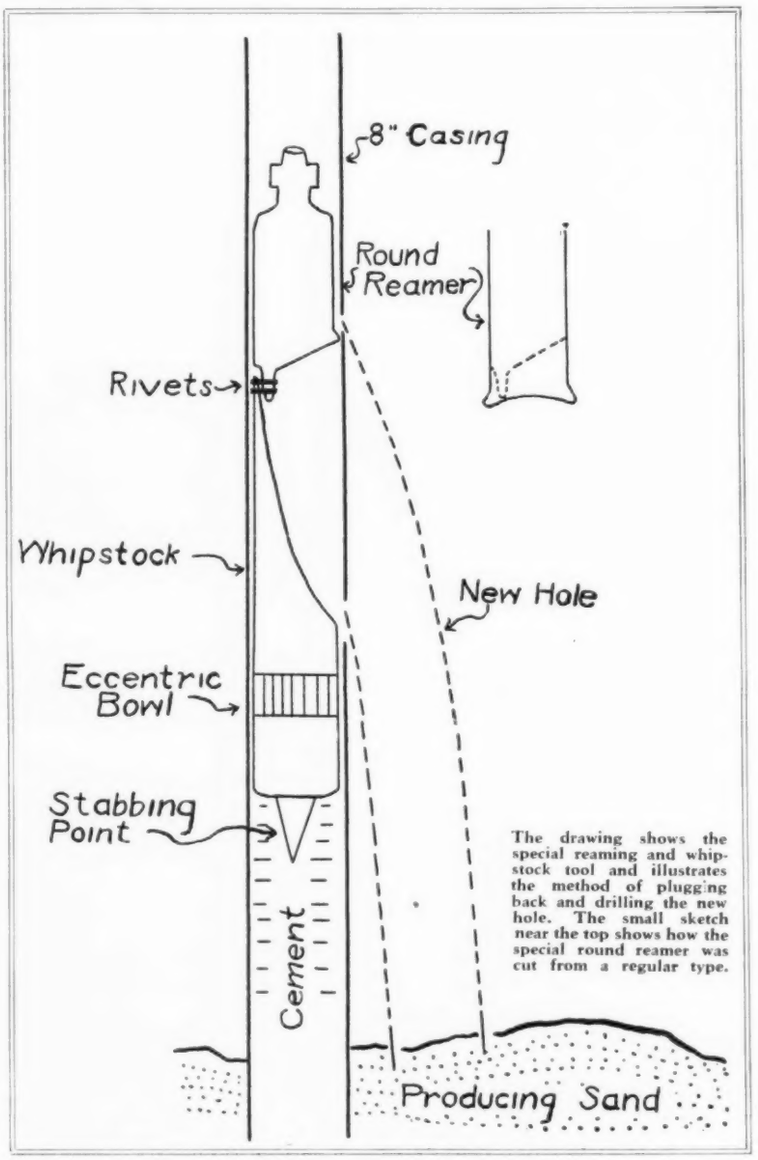
The lower portion of the special tool was comprised of a whipstock, on the lower end of which was a stabbing point for the purpose of preventing it from turning in the hole while reaming. An extra precaution against the turning of the whipstock was an eccentric bowl or slip located above the stabbing point. If the whipstock commenced to turn this eccentric bowl gripped the side of the eight-inch casing and held the whipstock in place.

Attached to the upper end of the whipstock by two rivets was a special designed round reamer, cut from a regular reamer. The two were attached together as a means of lowering the whipstock into place in the hole, but when drilling operations were started the weight placed on top of the reamer was sufficient to cause these rivets to shear off, which action permitted the reamer to slide down the slope of the whipstock, cut out through the eight-inch casing and proceed with drilling of a new hole to the pay sand.

The hole, within the eight-inch casing, was plugged back by pouring cement into it until the cement level was 200 feet above the depth of the upper pay horizon. While the cement was still soft the special whipstock and reaming tool was lowered into the hole and the stabbing point of the whipstock allowed to penetrate the cement. The well was shut down until the cement had hardened before reaming.

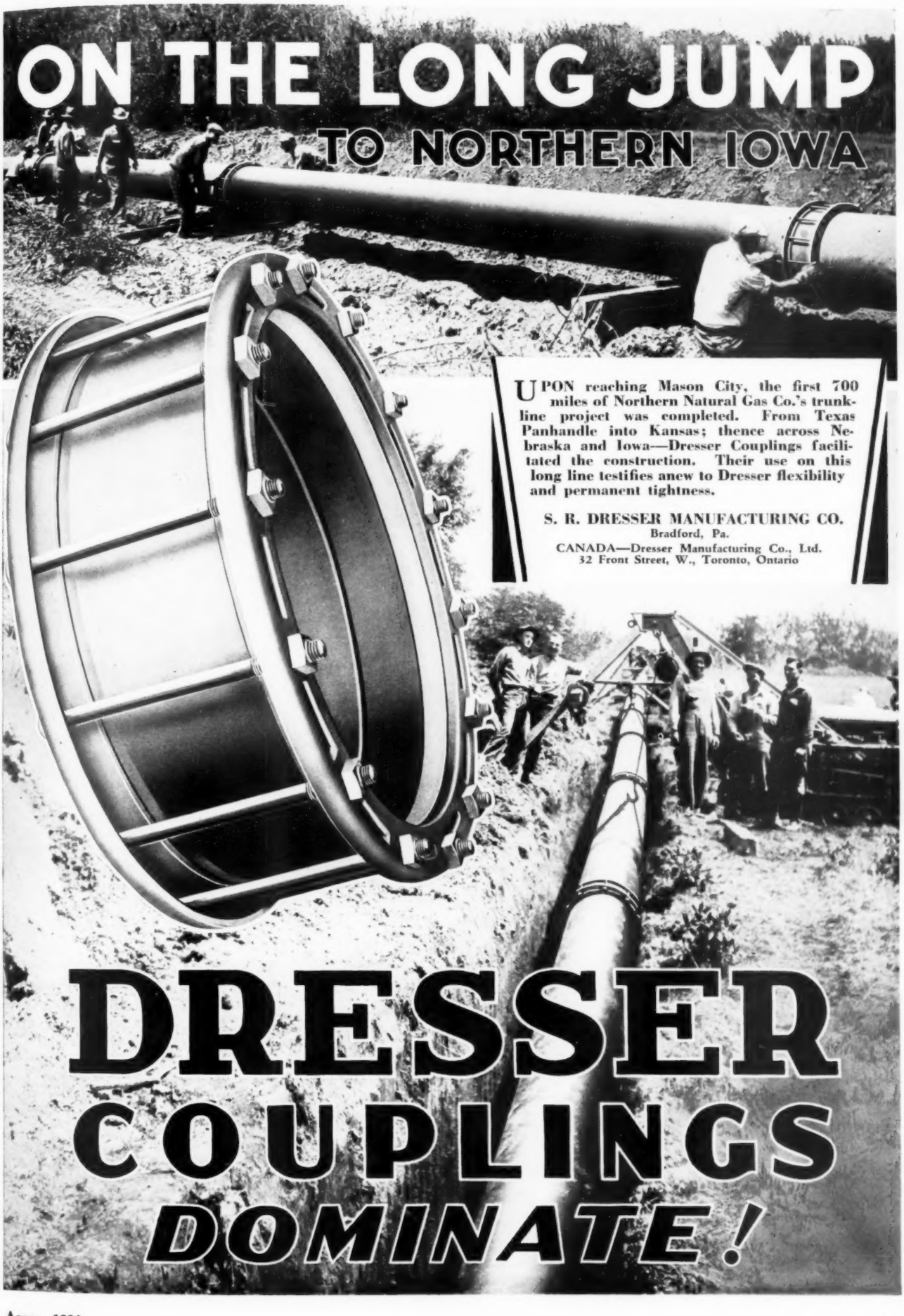
The reamer went out of the eight-inch casing at 2,460 feet and reached the top of the producing formation at 2,733 feet, after making 273 feet of new hole. The six-inch casing, which is the flow string to the new sand, was carried throughout the reaming operations because of the cavey characteristics of the formation penetrated. When drilling was started it was believed the hole would vary from the vertical about three degrees at the start and that the hole would be from 15 to 20 feet off vertical when the producing horizon was reached. However, it was found that the new hole had a tendency to straighten and therefore did not deviate from the vertical as much as the owners anticipated.

This well had been producing from the Wilcox sand at 4,200 feet and the decision to plug back followed its decline in production and the discovery of a large producing well in the upper sand when an offset well was plugged back and completed with perforated pipe.



The drawing shows the special reaming and whipstock tool and illustrates the method of plugging back and drilling the new hole. The small sketch near the top shows how the special round reamer was cut from a regular type.

ON THE LONG JUMP
TO NORTHERN IOWA



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EFFECT *of* SIZE ON THE PERFORMANCE *of* DRILLING BITS

By R. A. SILENT*
Member A. S. M. E.

A REAL comparison of the relative digging qualities of various sizes of bits used for oil well drilling is very difficult. This is due to the large number of empirical variables which affect the performance of the bit and which must be taken into consideration in comparing results. Among these variables may be enumerated various characters of formation; changes in formation during the period considered; the suitability of the bit to the formation; the pressure with which the bit is pressed into the formation; and the speed of rotation, etc.

Of secondary consideration is the weight, quality and viscosity of the fluid or mud used to remove the cutting. In fact, the conditions vary so much that the ordinary comparisons of bit runs are seen to be of little value as soon as inquiry is made as to the empirical conditions affecting such runs. For these reasons a logical deduction of the probable performance of various sizes and types of bits, based on known physical principles, reduced to lowest terms, should be of equal or more value than the ordinary test data based on the average indiscriminate tests. By "reduced to lowest terms" is meant a clear statement of the conditions under which comparisons are to be made; viz., a run in a formation of constant texture during the period of the test; an adequate flow of fluid of proper density and viscosity to carry the cuttings; constant pressure on the cutting surface; and constant speed of rotation.

The simplest comparison as to the performance of various sizes of bits, may be made with bits of the fishtail type. If we consider a twenty-inch bit and a ten-inch bit (Plate 1) each digging one inch depth of hole under the conditions stated in the paragraph above, we have for the ten-inch bit, ten inches or a trifle less of cutting edge. This cutting edge must excavate 78.54 cubic inches of material in digging one inch depth of hole; or every lineal inch of cutting edge must excavate 7.85 cubic inches of material. The twenty-inch bit has twenty inches, or a little less of cutting edge, which in digging one inch of hole has to excavate 314.16 cubic inches of material; or 15.75 cubic inches per inch of cutting edge. If we consider a twenty-five-inch bit, with a twenty-five-inch cutting edge, we find that 490.87 cubic inches of material must be excavated for one inch depth of hole; or for the above, the rule is that the probable wear on the bit of the fishtail type bears a direct ratio to the diameter of the hole cut. A ten-inch bit should dig twice as much depth of hole, with the same wear on the cutting edge, as a twenty-inch bit. But we must remember that the dressing and hard-facing of a twenty-inch bit requires twice as much hard-facing material, etc., as a ten-inch bit, so that the actual cost of dressing, or bit maintenance cost, per inch of hole, in the case of the twenty-inch bit, is four times that of the ten-inch bit; or the bit maintenance cost increases, approximately, as the square of the diameter.

It may be argued that the foregoing conclusions are not warranted, by reason of the fact that bits do not wear evenly across their cutting edge, and that the first wear on bits occurs on their outer corners; and that a bit becomes "out of gauge" rapidly and must be redressed to size and refaced, in order to maintain a proper sized hole, etc. Thus, the time a bit can be used depends on the wear on the outside corners, rather than the general wear.

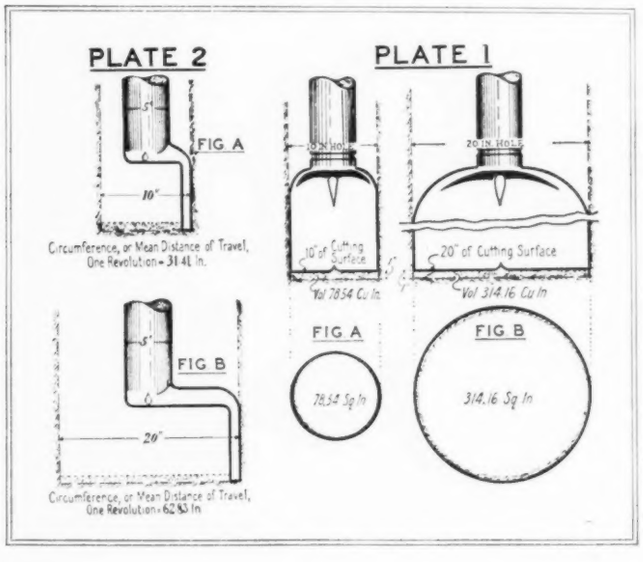
To investigate the effect of this wear, consider two bits to be run in the bottom of a ten-inch and a twenty-inch hole, respectively, these bits to have a cutting width of one inch only, and to be constructed as per the drawing Plate "2"; viz., each bit to cut a path one inch wide around the outer circumference of the hole. In the case of the ten-inch bit, we find that the outer cutting edge travels a distance of 31.41 inches in making one revolution. It will, therefore, be seen that with half the contact with the abrasive formation per revolution, the ten-inch bit should dig twice as much depth of hole with the same wear as the twenty-inch bit. Or, as the distance of travel per revolution, in contact with the abrasive material varies directly as the diameter; and as the wear on the outer corners of the twenty-inch bit is twice that of the ten-inch bit, for any given depth of hole made, it follows that two bits should wear before becoming out of gauge, directly proportional to their diameters.

This conclusion represents only half of the amount of proportionate wear and cost deduced in the paragraph above covering general wear, which was expressed as the square of the diameters, and for practical purposes it is probable that the real answer lies somewhere between the two figures.

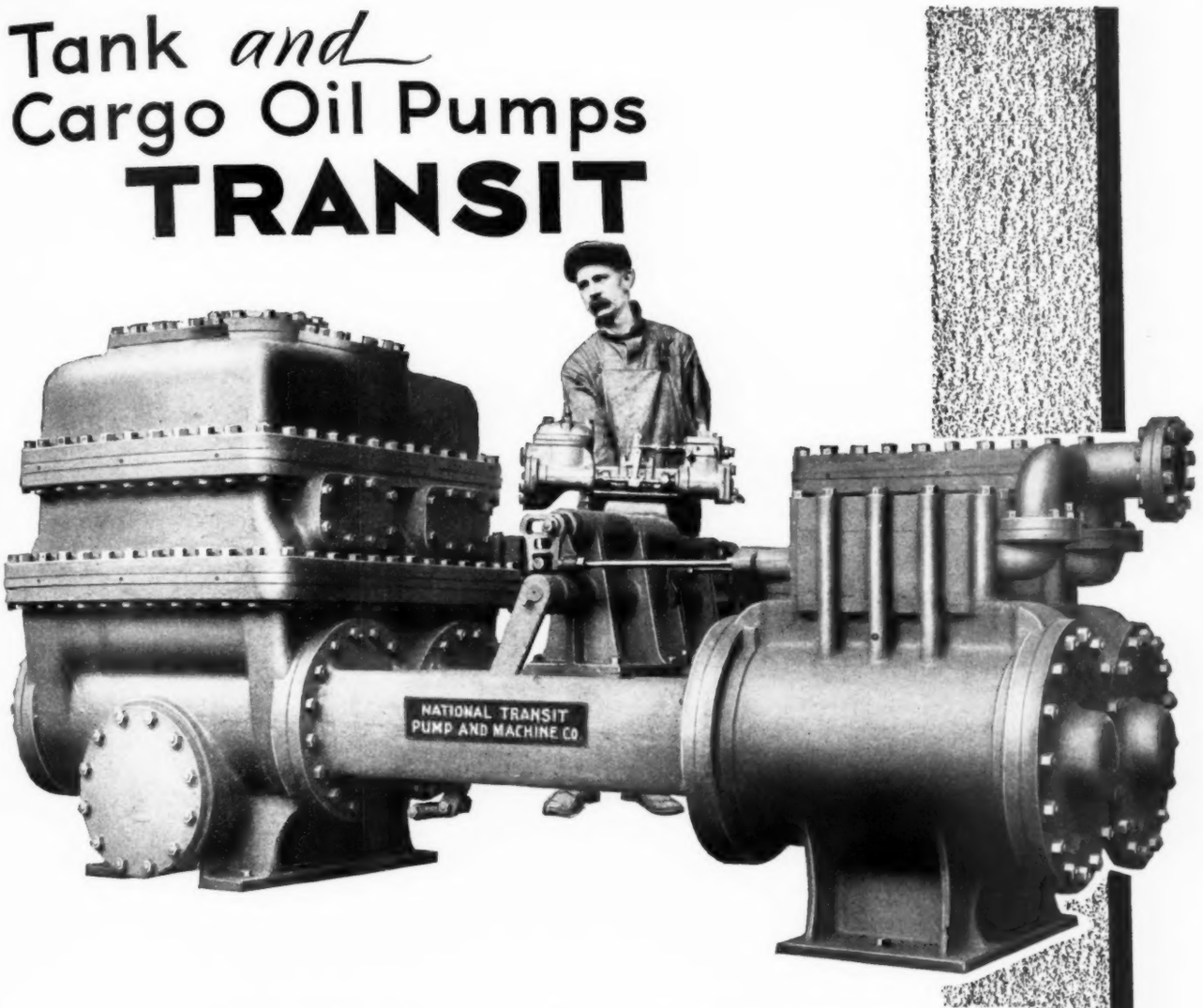
In case of disc or core type bits, there is another factor which enters into the question of wear, and that is the diameter of the discs or cones used on each size of bit, or what may be termed the "virgin metal" capacity of each size of bit. Manifestly, two bits cutting the same sized hole, one of which has discs of double the circumference and surface of cutting metal over the other, will wear twice as long or dig twice the hole. The same is true of cones or grinding discs. However, the sizes of the discs or cones are limited by the size of the hole being cut, and within certain limits these sizes are proportional to the hole diameter.

A safe rule may be deduced similar to that in the preceding paragraph; viz., that the minimum disc costs for the disc and cone type bits should be proportional to the hole diameter.

* Engineer Doheny Stone Drill Company, Los Angeles, California.



Tank *and* Cargo Oil Pumps
TRANSIT



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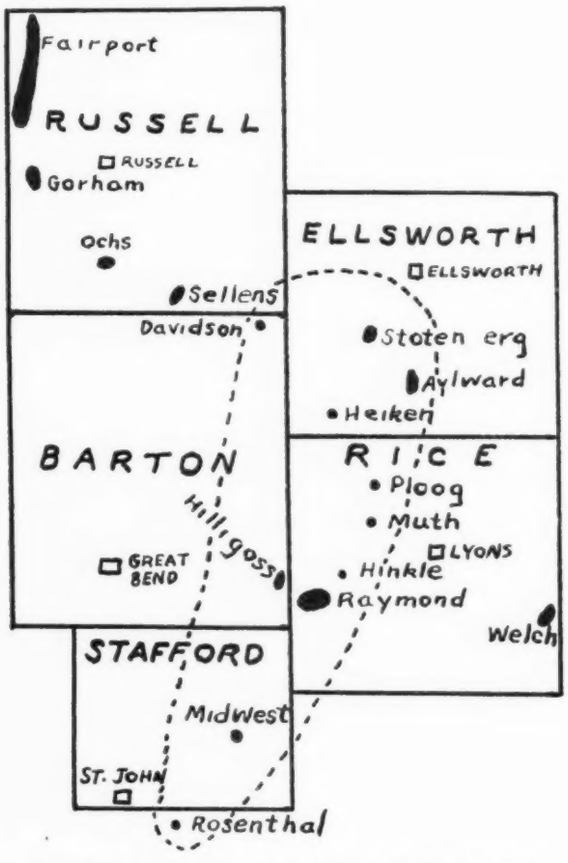
General Operating Conditions of

NEW WEST KANSAS AREA

THE Barton-Ellsworth Arch, embracing parts of Ellsworth, Barton, Rice and Stafford counties, western Kansas, extending 70 miles north to south, with a dozen pools, mostly represented by one well, already discovered, is looked upon by many as a very promising prolific oil producing area of considerable size and importance. Although the district has but recently become very prominent it has been in process of development for the past two and one-half years, with leasing and geological work done as far back as five to six years ago.

The development of the entire area has been retarded by a limited market outlet and heavy restrictions on production, but at present is receiving its most intensive drilling campaign. The district is removed from major pipelines and most of the discovery wells have been capped awaiting a market. In the fall of 1930 the Prairie Pipe Line Company completed an eight-inch line from McPherson to Raymond, but it was shut down when the company withdrew as an active purchaser. The Stanolind Crude Oil Purchasing Company has recently built a system of gathering lines to many of the various pools, connecting them with both the Prairie Pipe Line system and with loading racks. The Kansas Public Service Commission has issued an order which limits the production output to a unit, consisting of 40 acres, so at present the area is being developed with one well to each 40 acres.



Outline Map showing relative positions of producing wells in Barton-Ellsworth Area.

So far a total of 30 producing wells and 79 dry holes have been completed in a territory ranging from 9w to 12w and 16s to 24s, inclusive. Since the region produces from the Siliceous lime it is natural that it should be spotted as the characteristic of this producing zone to be erratic. The Raymond pool is the largest producing spot, having 12 oil wells and one gas well. Other areas having more than one producer are the Aylward with three, and the Stotenberg and Hilligoss with two each.

The district will be principally a pumping one as the wells have very little or no gas, and an average pressure at the flow line gates of but 400 pounds per square inch. The usual pumping engine used is of 40 horsepower, while a few companies use a 25 horsepower unit. Most of the wells are tubed with 2½-inch tubing, although some two and three-inch strings are installed. Sucker rods vary from ⅝-inch to ¾-inch and ⅞-inch, depending upon the size of the tubing.

The average well has four 250-stock tanks, one 210-gun barrel and one 375-barrel settling tank. The gun barrel and settling tanks are needed because the wells are also water producers, already 20 per cent of the new wells are making some water.

The average depth of the producing horizon is 3350 feet and it is penetrated about nine feet. These wells produce on an average of 500 barrels each of 37 gravity oil for initial production, although some much larger wells have been found.

Drilling conditions in the district are quite simple and offer no hardships in reaching the oil-bearing horizon. Cable tools are used for drilling, with only a few exceptions, and are powered by either steam or gas engines. These standard derricks, which are sometimes constructed of wood, are 84 feet in height. A belt 14-inches wide and about 180 feet long is employed to transmit the power from the engine to the band-wheel. The cost of completing a well in the district is close to $30,000 and contractors' price per foot for straight drilling is around $4.00.

The casing program used in the district usually consists of 20 feet of 20-inch pipe; 900 feet of 12-inch; 2000 feet of 10-inch; 2500 feet of eight-inch; with either a six or five-inch string set on top of the producing sand.

The Barton-Ellsworth Arch district is located about 30 miles west of McPherson and about 100 miles northwest by road from Wichita. Outside of the main highways the region does not have much to offer in the way of roads, as they become practically impassable in wet weather and during the winter are frequently blocked with snow.

This new area is quite amply supplied with railroad facilities, there being four different roads in the region. The A. T. & S. F. passes through Great Bend, the Missouri Pacific and S. L. & S. roads are at Lyons and the Union Pacific is at Ellsworth.

The topography of the country is prairie-like, being practically flat with very little roll. Because of its flatness there are but few creeks, which are depended upon for water to aid oil field work, therefore water is rather scarce.

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Very Latest Design Features Sinclair's East Texas Pumping Rigs

PRODUCTION engineers of the Sinclair-Prairie Oil Co. have carefully considered the necessity of obtaining the utmost economy in pumping operations when equipping their company's East Texas wells for pumping purposes. The result has been the installation of some very fine pumping units.

Rigid economy in pumping operations has become a necessity in recent years because of the low price that has been, and is being, received for crude production. However, the initial layout is not always the most important factor in efficient operation as frequently higher-priced units will more than offset the additional original expenditure by lower upkeep costs and better results.

While the initial cost of the units being placed in East Texas by the Sinclair company may be slightly higher in original cost than many others in the field, they are expected, over a long period of time, to reward the operators through lessened troubles and consequently lower upkeep, less downtime and more efficient operation generally.

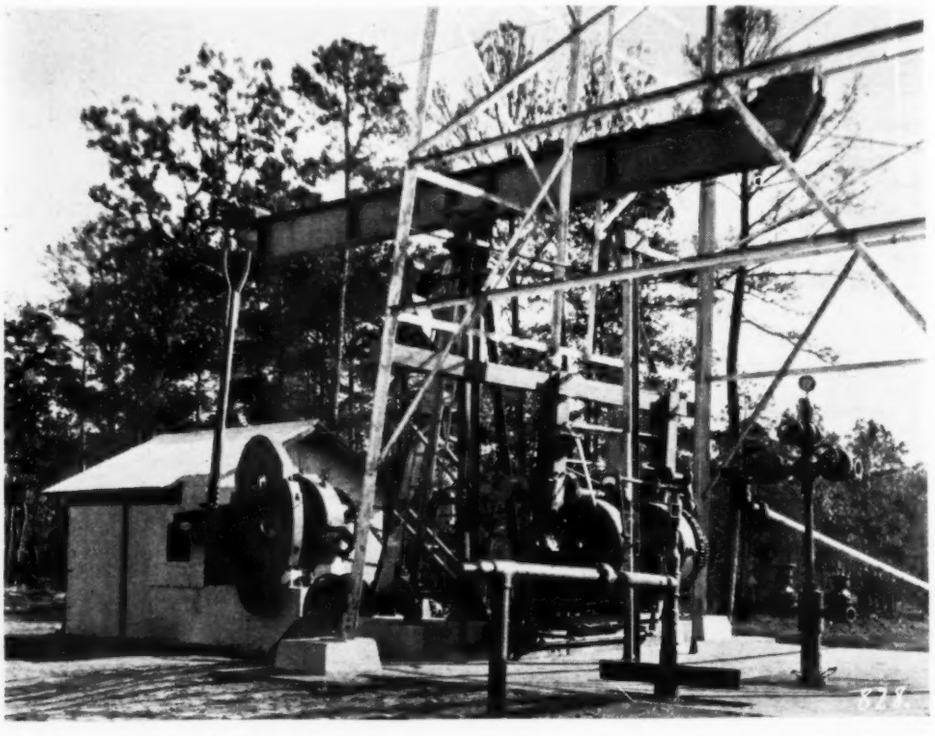
The units being installed are of the latest heavy-duty, modern design, and are of the counter-balanced crank and gear unit type, operated by electric motor. The walking beam, sampson post and pitman are of steel, as is also the derrick.

These units have been installed with extreme care and attention to eliminate rig racking from vibration and, consequently, equipment wear from shock due to severe side motions and the like. All foundations for the units are of solid concrete, onto which are bolted the various pieces of equipment making up the units, which gives the installations sturdy, long-life and fireproof features. Even the rig floor is of poured concrete and it has been laid directly on top of the ground to eliminate the cellar. While the outstanding importance of such construction is the material reduction in vibration, long rig life and fireproof characteristics, they are also unusually neat in appearance and may easily be kept clean.

At first thought one would think such a unit an expensive one, but several factors have been taken into consideration by the engineers to keep the operating cost down to a point where quick returns on money invested may be expected from the elaborate construction. These plans include initial lay-out cost, upkeep and pulling operations.

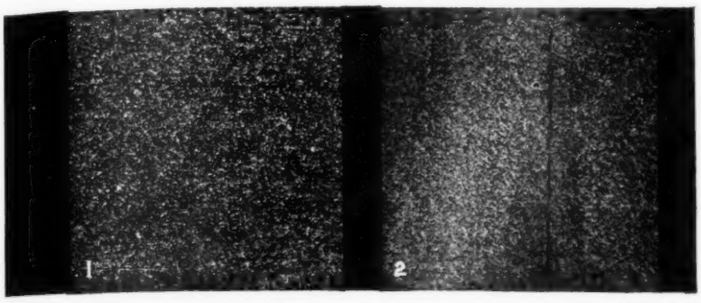
When flowing wells reach the stage in their life where they are ready for the pump, they are ordinarily cleaned out before the pump is installed. This operation is performed by cable tools, using a 75-horsepower electric drilling motor as power. After the cleaning-out job is completed the drilling motor, steel hoist, sand reel and motor housing is removed to be used on other wells.

It is possible to remove the housing, of portable type, as a weather-proof, enclosed, 25-horsepower squirrel-cage motor is used for pumping the well. Pulling operations are to be done with truck winches. This plan materially reduces the cost per well and yet does not lessen its efficiency.



A Sinclair company well in the Joiner pool of East Texas while equipped for cleaning out. Note the fine construction that has been done of these modern producing rigs.

EVERY TEST PROVES
THE STRENGTH OF WELD



At left—No. 1—Typical structure of Republic Electric Weld Pipe Wall.

At left—No. 2—Same pipe as at left showing typical structure at weld.

IT IS AND IT ISN'T A WELDED PIPE

Republic Electric Weld Line Pipe, Casing and Tubing actually is welded pipe, made by electric welding under the original Johnson Patents. But from the standpoint of performance the weld is non-existant, and it is by performance that it should be judged.

If you are inclined to question—remember these facts. Under the miscroscope the structure at the weld is practically the same as at any other point in the pipe wall. Tensile tests show more fractures away from the weld than at the weld. Twist tests with the weld longitudinal or at right angles to the test strip show no weakness. Expansion and vanstoning show no fractures at the weld. Hydrostatic tests to failure show that the weld has no relation to the position of rupture. And of more than 5000 miles in use, not a single length has failed in service.

So forget that there is such a thing as a weld in Republic Electric Weld Pipe. Actually it is there, but for all calculations, the strength of the weld may be considered as the strength of the wall,—this by no less an authority than the U.S. Bureau of Standards.

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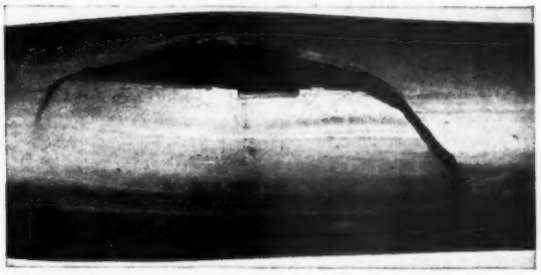
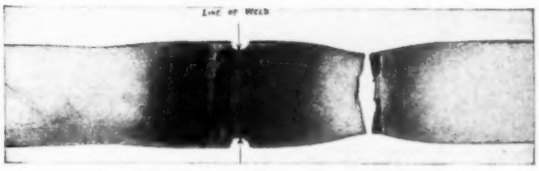
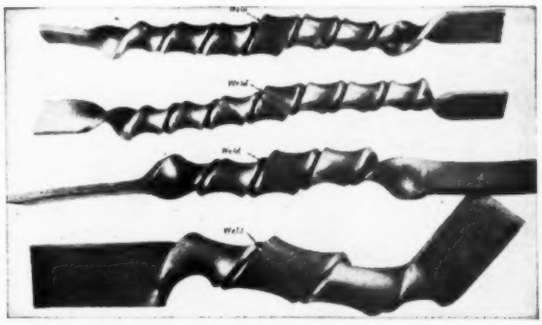


Pittsburgh Testing Laboratory test. Bursting Pressure 4,200 lbs. per sq. in. Rupture occured away from weld.



Tensile test with ¼-inch diameter notch at weld.

Ductility (twist) tests on electric weld pipe with weld longitudinal through center.



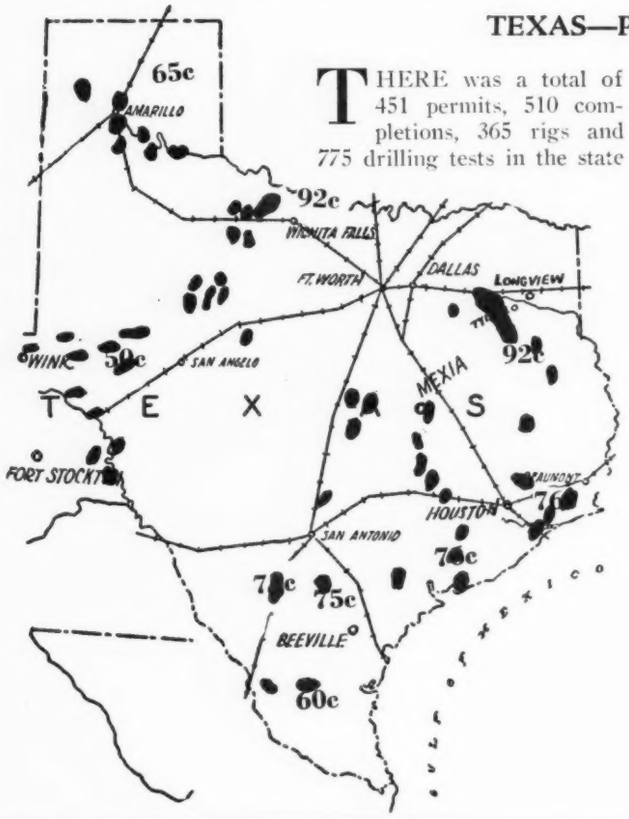
Ductility (twist) tests on electric weld pipe with weld at right angles to axis of test strip.

Showing vanstoning quality of electric weld pipe.

Ductility (expansion) test on electric weld pipe.

Latest Activities *in the* Oil Fields*

TEXAS—Production, 1931—330,720,000 Barrels



THERE was a total of 451 permits, 510 completions, 365 rigs and 775 drilling tests in the state of Texas during the month of March. The number of permits and completions represents a decline from the previous month, while rigs and drilling wells are a little above the previous month's figure.

East Texas, although showing a slight decline, continues to represent approximately three-fourths of the state's operations.

Following is a tabulated report of several fields:

	POOLS		
	East Texas	Pan-handle	Van Field
Number of Permits	247	5	8
March Completions	337	6	10
Number of Rigs	89	14	1
Number Drilling Wells	612	40	21
Gravity of Oil	40	40	36
Depth of Production	3600	2900	2600
Type of Tools Used	Rotary	Rotary	Rotary
Number of Casing Strings	2	2	2

CALIFORNIA

Production, 1931—188,575,000 Barrels

There were 25 new drilling permits, or locations, made in California during March, during which time but 16 wells were completed. This accounted for a slight increase in drilling operations, the state having 20 rigs and 143 drilling tests at the close of the month.

Following is a survey of some of the more active fields in the state:

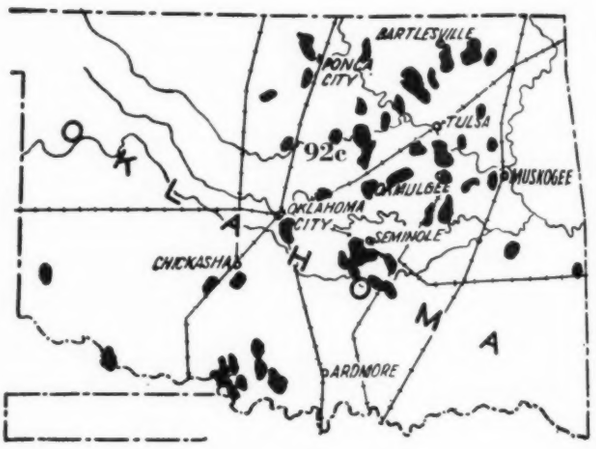
	POOLS			
	Playa Del Rey	Long Beach	Kettleman Hills	Ventura
Number of Permits	0	1	0	1
March Completions	1	1	0	0
Number of Rigs	0	1	0	1
Number Drilling Wells	1	6	13	3
Gravity of Oil	23	26	60	36
Depth of Production	6000	7000	8300	7800
Type of Tools Used	Rotary	Rotary	Rotary	Rotary

*All statistics as of March 1st.

● Denotes oil and gas fields.

OKLAHOMA

Production, 1931—177,750,000 Barrels

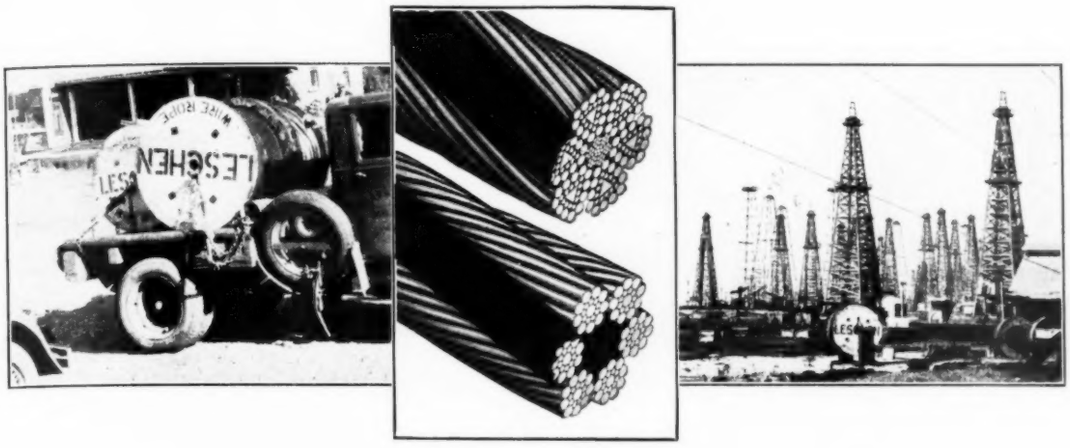


A decided increase in the number of drilling wells for the state was due to activity in the new southwest extension at Oklahoma City and to several wildcats.

Following is a summary of Oklahoma's activity:

	Entire State	Oklahoma City
Number of Permits	77	17
March Completions	78	10
Number of Rigs	55	15
Number Drilling Wells	123	36
Gravity of Oil	36 (average)	39
Type of Tools Used	Rot.-Cab.	Rotary
Number of Casing Strings	Varies	3
Depth of Production	Varies	6500

Figures on maps indicate average prices of crude oil per bbl.



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(3) Our manufacturing methods and machines insure even tension on both the wires and the strands.

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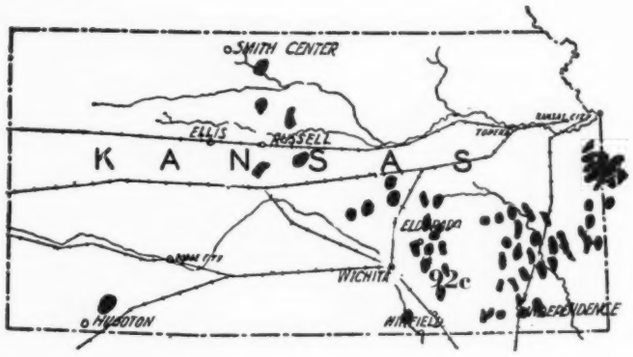
KANSAS—Production, 1931—37,950,000 Barrels



Kansas had 41 new drilling permits issued last month, while 30 tests were completed, 15 were rigs and 70 were drilling. Both rotary and cable tools are used in the state, with the latter the most common.

Following is a report of the activities in the three most active spots of the state:

	POOLS		
	Sedgwick County	Ellsworth Arch	McPherson County
Number of Permits	3	10	11
March Completions	4	1	7
Number of Rigs	1	6	11
Number Drilling Wells	7	15	19
Gravity of Oil	39	37	38
Depth of Production	2900-3500	3300	2900-3400
Type of Tools Used	Rot.-Cab.	Cable	Rot.-Cab.
Number of Casing Strings	2	4	2

ARKANSAS

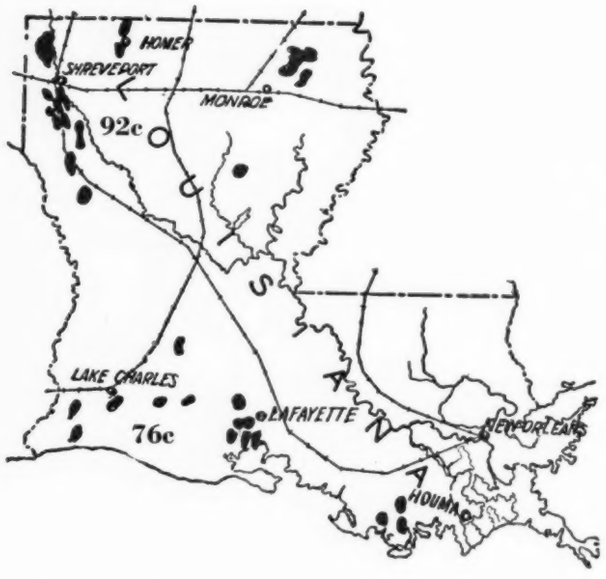
Production, 1931—15,425,000 Barrels

There were 9 rigs and 27 drilling tests in Arkansas during the month of March. The state had but one completion and one drilling permit for the month.

Rotary type tools are used by contractors for drilling purposes in the state, where formations frequently carry large gas pressures and are usually soft and cavey.

LOUISIANA

Production, 1931—22,325,000 Barrels



Louisiana had 22 new drilling permits, 30 completions, 22 rigs and 74 drilling wells for its oil field activities during March. Rotary tools are operated in both the Gulf Coast and North Louisiana areas.

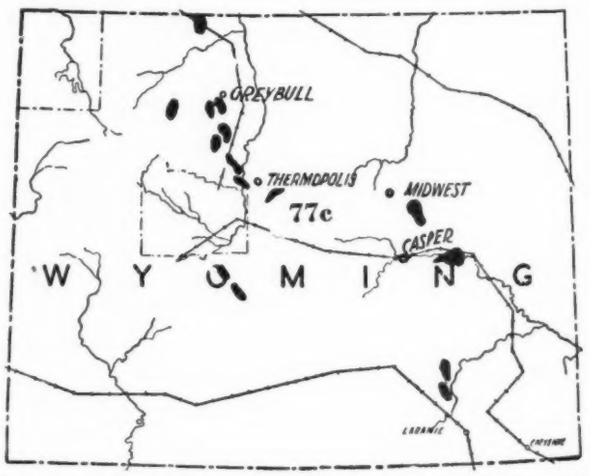
Mississippi, adjoining Louisiana to the east, had 2 completions, 9 rigs and 13 drilling tests.

●Denotes oil and gas fields.

WYOMING

Production, 1931—14,725,000 Barrels

There were 4 completions, 10 rigs and 60 drilling tests in Wyoming last month. Practically all the tests were cable tool installations.



Figures on maps indicate average prices of crude oil per bbl.

NEW YORK

Production, 1931—3,400,000 Barrels

PENNSYLVANIA

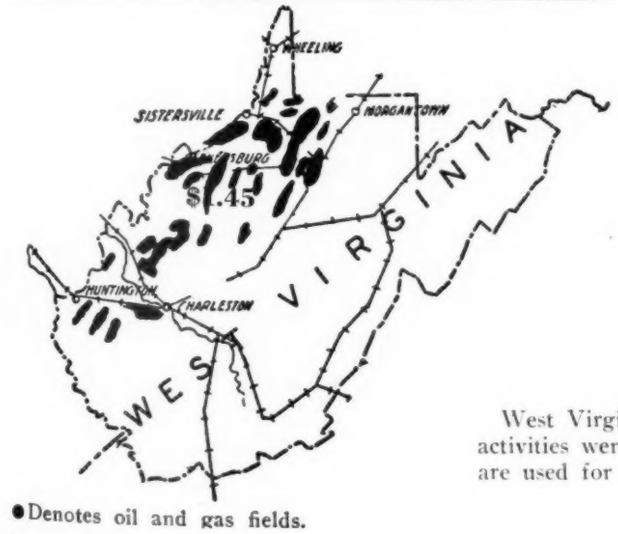
Production, 1931—11,225,000 Barrels

Pennsylvania had 55 completions last month, while New York had but 7. The total combined operations of the two states consisted of 11 rigs and 80 drilling tests, all of which were standard type tool rigs.

ILLINOIS

Production, 1931—4,850,000 Barrels

The state of Illinois had a total of 3 completions in its oil fields during the month of March. A total of 19 tests were drilling, while only one operation was reported as a rig. Standard tools are used by operators for drilling purposes in the state.

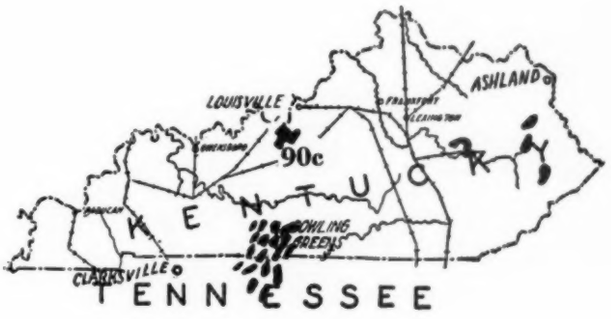


● Denotes oil and gas fields.

KENTUCKY

Production, 1931—6,490,000 Barrels

The state of Kentucky had 21 completions, 6 rigs and 75 drilling tests last month. Tennessee had no completions and 14 drilling tests. Cable tools are used by operators of both states.



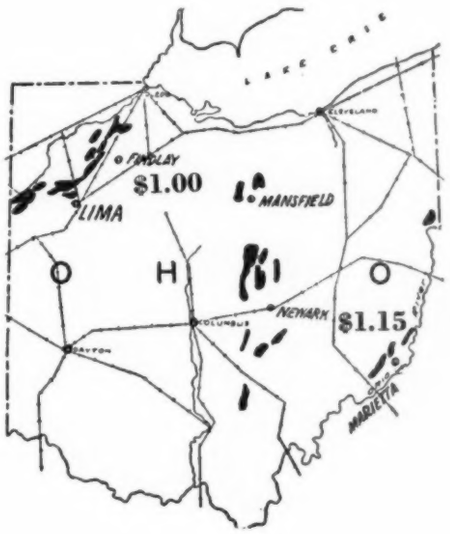
TENNESSEE

Production, 1931—8,000 Barrels

OHIO

Production, 1931—5,315,000 Barrels

The state of Ohio had 56 completions during the month of March, while 110 tests were drilling and 37 rigs were listed for the month. Cable tools are utilized for all drilling operations in the state, where the producing horizons are comparatively shallow and easily reached.



WEST VIRGINIA

Production, 1931—4,480,000 Barrels

West Virginia had a total of 21 completions last month. Other oil field activities were comprised of 17 rigs and 38 drilling tests. Standard tools are used for drilling purposes in the state.

Figures on maps indicate average prices of crude oil per bbl.

NEW MEXICO

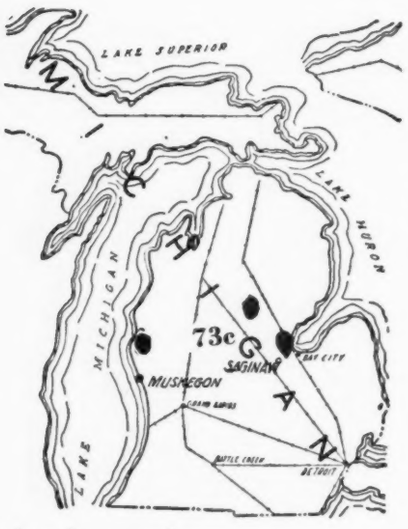
Production, 1931—15,250,000 Barrels

There was a total of three completions made in the oil pools of New Mexico during March, at the close of which time the state had 8 rigs and 46 drilling tests.

Both rotary and cable tools are used in the state, with the former outnumbering the standard tools. Rotaries are used primarily in the southeastern section of the state, where producing horizons are around 4000 feet in depth and where heavy pressure upper horizons are encountered.

MICHIGAN

Production, 1931—3,730,000 Barrels



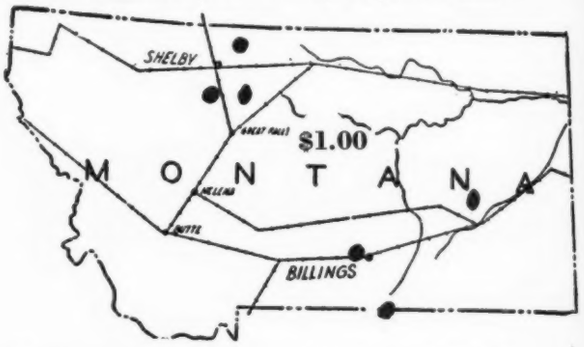
There was a total of 8 oil tests completed in the state of Michigan during the month of March. This state at the end of the month had 54 new rigs and 80 drilling tests within its boundaries.

Operators of the state do their drilling with cable tools, except in a few instances where rotary tools have been used.

● Denotes oil and gas fields.

MONTANA

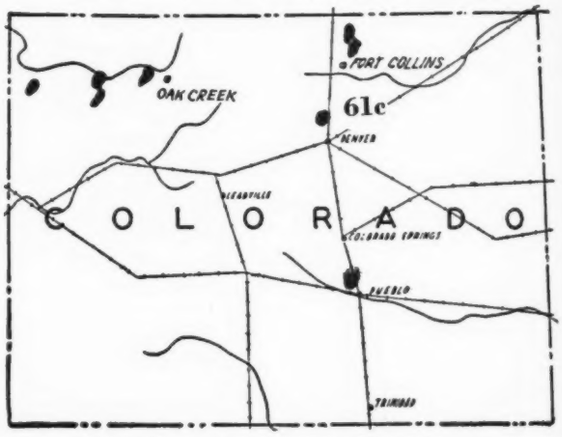
Production, 1931—2,855,000 Barrels



Montana had 2 completions, 12 rigs and 48 drilling wells last month. Cable tools are the most common means of making hole in the state.

COLORADO

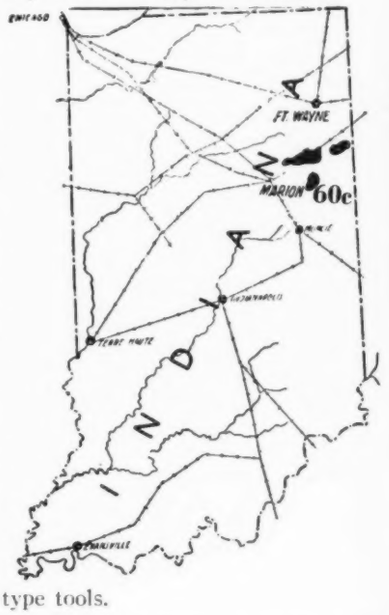
Production, 1931—1,510,000 Barrels



Three completions, 10 rigs and 70 drilling tests comprised Colorado's oil field operations for the month of March. Both rotary and cable tools are used here.

INDIANA

Production, 1931—830,000 Barrels



Indiana oil pools had a total of 13 tests completed during the month of March, as compared with 30 the previous month. A slight increase in the number of drilling operations was noticeable when the state's report showed 55 tests drilling within its boundaries. The only other field activities was one rig.

Drilling operations in the state are conducted with standard type tools.

Figures on maps indicate average prices of crude oil per bbl.

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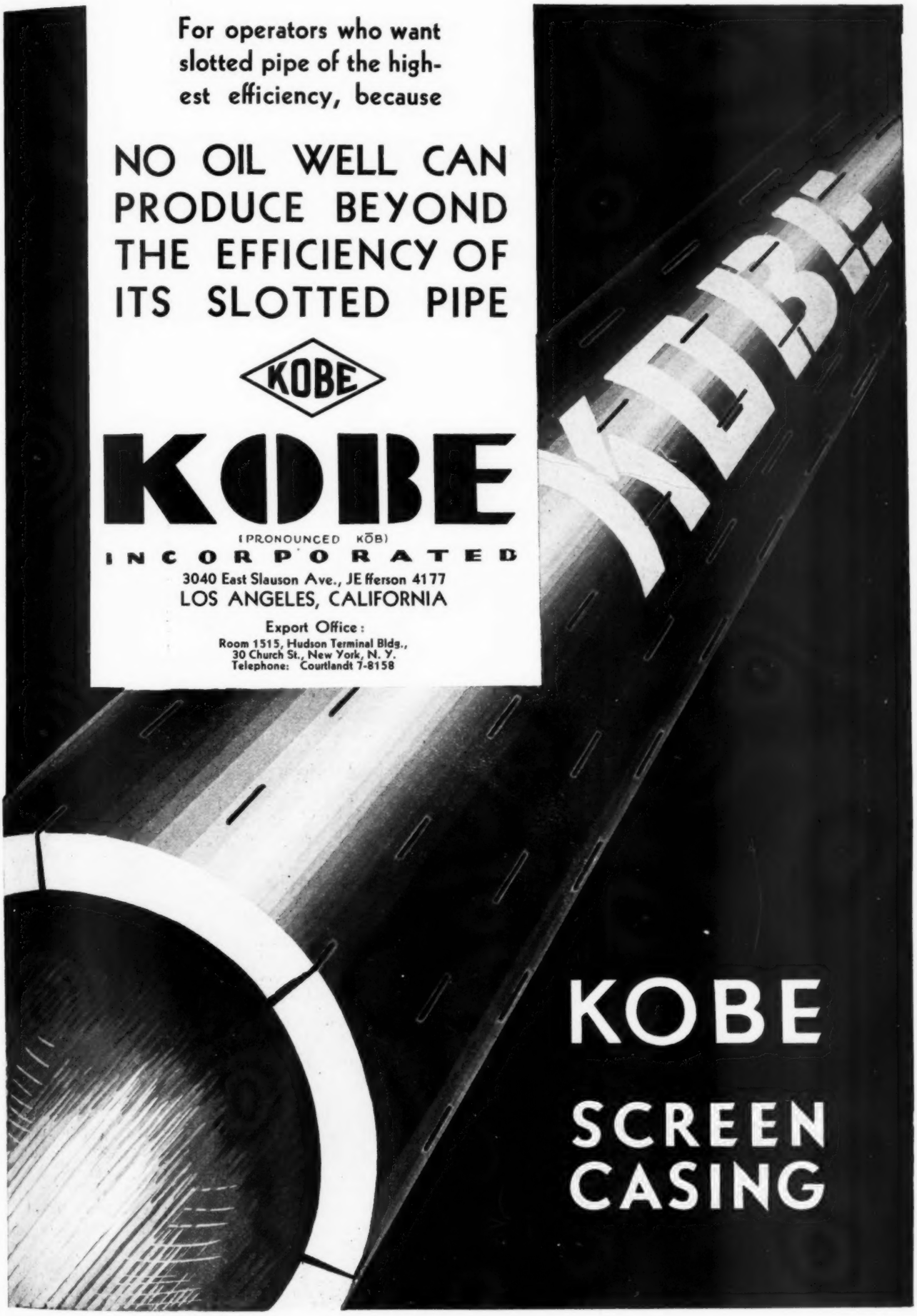

Progress of Major Pipe Line Work

By J. H. DAMERON

WITH the opening of spring a resumption of pipe line work is expected by several companies. At present there are no indications of major projects involving hundreds of miles being started, but several smaller jobs may be started.

Indications at present point to considerable work in the North, Northwest and on the Pacific Coast. Numerous projects are in the formative stage in the North and Northwest and the decision to build some of these may be made before summer. These involve lines from the northern Rocky Mountain fields into territory heretofore not served with gas. Some of the companies operating in that area are to a point where plans are being finished for considerable lateral line construction.

Several lines originating in the Southwest territory and terminating in the Northern areas likewise have considerable work mapped out for the expansion of their systems. Some of these companies are making strenuous efforts to extend their mains into some of the large industrial cities of the North. These efforts will depend largely upon the success of negotiations with companies operating manufactured gas plants in those cities.

On the Pacific Coast considerable new work has already been announced. The Southern Counties Gas Co. plans the construction of a 68-mile, 12-inch welded gas line to serve San Diego, Calif. The latter city has manufactured gas at present. The new line will originate at Huntington Beach and tie into the San Diego system at La Jolla. Construction work on this project is expected to be started June 1. The Pacific Gas & Electric Co. has already started work in connection with the expansion of its present transmission system. This work involves the construction of a large diameter short length line.

Numerous oil pipe line companies are preparing to do considerable repair and reconditioning work during the spring and summer. Some of these companies are reported to have completed plans for the looping of part of their systems in the event a tariff is imposed on imported crude. In the latter event some of the transporters would require additional capacity for their systems running to eastern refining points.

Frequently rumors are heard concerning the construction of new gasoline lines out of the Mid-Continent to large markets. Most of these involve three or more companies reported to be considering pooling their interests and building a joint line. Another persistent rumor is that railroad engineers are considering the construction of gasoline pipe lines to meet the stiff competition offered when oil companies build their own. The railroads have the advantage of having their own right-of-way.

Both of the two gasoline carriers coming out of the Mid-Continent and terminating in northern and central U. S. markets are reported considering increasing their capacity. One line has been building booster stations and the other is also considering increasing capacity by the installation of boosters.

Construction work to increase the capacity of this line may be started within the next 30 days. Present plans are to build at least one station for experimental purposes and build other stations during the summer months.

Phillips Petroleum Co., through its transporting subsidiary, Phillips Pipe Line Co., started construction of a six-inch line from Oklahoma City to storage at Earlsboro in the Seminole area. Shortly after construction work was started by Kelly-Dempsey & Co., Tulsa, Okla., contractors, the work was shut down and the Phillips company closed a deal with the Prairie Pipe Line Co., which has an eight-inch line running parallel almost all of the way along the Phillips company's right-of-way.

Phillips company had planned to take up approximately 50 miles of six-inch gathering lines in the Wewoka area and use this in the construction of the Oklahoma City line. All of the work was to have been done by hand and approximately 15 miles of pipe had been taken up when the work was shut down. Equipment had been moved to Oklahoma City to lay the line. The Phillips company has considerable empty storage at Earlsboro and plans to give this storage a pipe line connection to its main line system in the near future.

Several small construction jobs are contemplated by various oil pipe line companies in the Mid-Continent and these may be started within the next few weeks.

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Procedure Controls for Lindewelding are available to all users of Linde Oxygen. Let our nearest district office show you how Lindewelding can save time and money on your next pipe line job.

Study Lindewelding Technique in this Motion Picture

Our motion picture, "The Lindeweld Process for Pipe Line Construction," shows every detail of Lindewelding technique, which differs from neutral flame welding technique in that it employs a special rod, a special flame adjustment, and the "backhand" method of blowpipe manipulation. It reveals the actual steps in making a Lindewelded joint. Pipe line officials and welding or engineering societies may borrow this picture free of charge by writing to any Linde District Office. It is furnished in 16 mm. and 35 mm. safety film.

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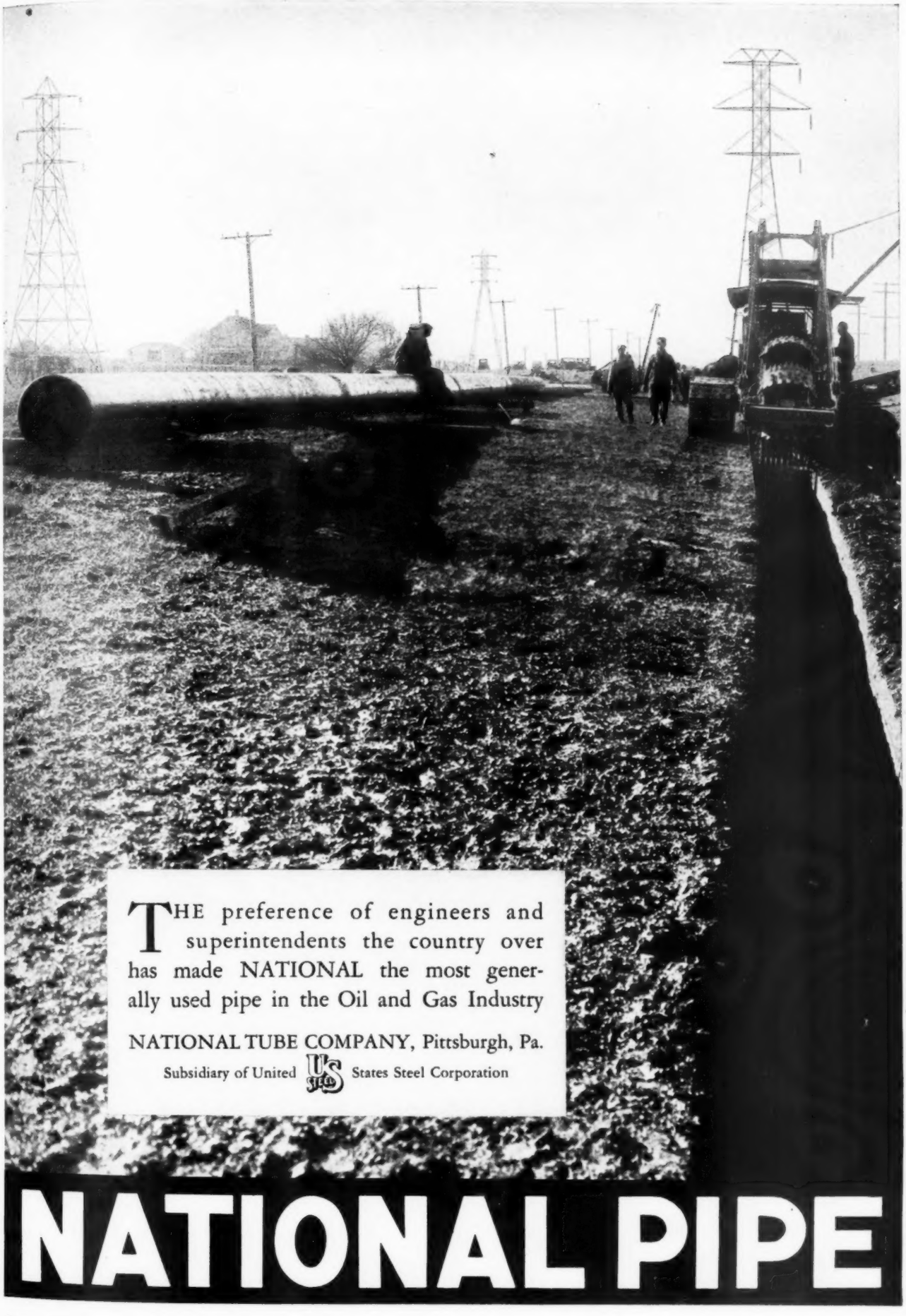
PIPE LINES UNDER CONSTRUCTION AND CONTEMPLATED

Type Line	Company Name	Headquarters	Point of Origin	Terminal	Size Pipe	Length in Miles	Remarks
Ga.L.	Atlantic Refg. Co.	Philadelphia, Pa.	Point Breeze	Wilkes-Barre, Pittsburgh	6-8"	475	Part of system operating. Plan extension of main line this year.
G. L.	Bivens, C. E., et al.	Laramie, Wyo.	Baggs Field	Laramie, Wyo.	12"	104	Plan to build in 1932.
G. L.	Big Bend Pipe Line Co.	Ft. Stockton, Tex.	(See Remarks)				Plan to extend present system with 60 miles of 4-inch.
G. L.	Columbia Gas & Elec. Co.	New York, N. Y.	Ky. or Pan Eastern Line	Detroit, Mich.	20"	220	Considering going to Detroit, Mich., with line and to Toledo.
G. L.	Continental Constr. Corp.	Chicago, Ill.	Chicago, Ill.	Detroit, Mich.	20"	200	Plan extension of Panhandle line to Detroit.
G. L.	Continental Constr. Corp.	Chicago, Ill.	Point in Ill.	Milwaukee, Wis.	20"	160	Buying right of way.
G. L.	Continental Constr. Corp.	Chicago, Ill.	Texas Panhandle	Chicago, Ill.	24"	1000	Plan to start parallel present line in 1932.
O. L.	Continental Oil Company	Ponca City, Okla.	Greasewood Flats, Colo.	Denver, Colo.	6"	70	Proposed—Held in abeyance.
G. L.	Cities Service, Insull, Texas Corp. & S. O. N. J.	(See Remarks)					Rumored considering building 1,500-mile project from Panhandle to Eastern cities.
Ga.L.	Great Lake Pipe Line Co.	Kansas City, Mo.	Okla. Midcontinent	Great Lakes Region	4-6-8"	1440	Considering increasing station capacity this spring.
O. L.	Gulf Pipe Line Co.	Tulsa, Okla.	Tulsa, Okla.	Spencerville, Ohio	10"		Plan looping present line and increasing station capacity.
G. L.	International Util. Corp.	New York, N. Y.	Alberta, Canada	Vancouver, B. C.	20"	500	Proposed.
G. L.	Jerome Drumheller	Spokane, Wash.	Cut Bank, Wyo.	Seattle, Wash.	20"	500	Proposed.
G. L.	Lycoming Nat. Gas. Corp.	New York, N. Y.	Tioga Field, N. Y.	Syracuse, N. Y.			Plan to extend main line from Syracuse to Oswego with 38 miles of 16-inch.
G. L.	Lewiston Nat. Gas Co.	Lewiston, Mont.	Armells Structure, Mont.	Mont. towns	4-6"	100	Proposed.
G. L.	Mid-Continent Public Service Co.	Fort Scott, Kan.	Field near Chanute	Fort Scott	8"	28	Moore-Creekmore Const. Co., Tulsa, have contract to build upon completion of plans.
G. L.	Missouri Valley P. L. Co.	Omaha, Neb.	Point in Minnesota	Minneapolis, Minn.	16"		Proposed.
G. L.	Montana-Dakota Power Co.	Minneapolis, Minn.	Williams, N. D.	Minot, N. D.	12"	100	Applied to N. D. Commission for permission to build.
G. L.	Mo.-Kans. Pipe Line Co.	Chicago, Ill.	Russellville, Ky.	Nashville, Tenn.	10"	50	Proposed.
G. L.	North Central Gas Co.	Casper, Wyo.	(See Remarks)				Reported planning 100 miles of extension work in Nebraska and near-by territory.
O. L.	Old Dutch Refining Co.	Muskegon, Mich.	East Michigan Fields	Muskegon	4"	100	Considering building.
G. L.	Ohio Oil Company	Findlay, Ohio	Weiser Field, Idaho	Boise and Northwest area			Filed application for conveyance certificate.
G. L.	Pacific Gas & Elec. Co.	San Francisco, Calif.					Have appro. for $2,000,000 expansion campaign.
G. L.	Panhandle Eastern P. L. Co.	Kansas City, Mo.	(See Remarks)				Reported planning 200 miles of lateral line construction in Missouri and Illinois.
O. L.	Stanolind Pipe Line Co.	Tulsa, Okla.	Mid-Continent	Chicago, Ill.	8-10"	360	Hoop work complete, station work complete.
Ga.L.	Sun Pipe Line Company	Philadelphia, Pa.	Point in N. Y.	Lake Ontario	6"	45	Extending to tidewater terminal.
G. L.	Southern Counties Gas Co.	Los Angeles, Calif.	Huntington Beach	La Jolla	12"	68	To supply gas to San Diego. Construction to start June 1. Line will be welded.
G. L.	Southern Nat. Gas Corp.	Birmingham, Ala.	(See Remarks)				Reported planning extension to Chattanooga, Tenn.
G. L.	St. Louis Industrial Fuel Co.	St. Louis, Mo.	(See Remarks)				Plan to enter St. Louis for industrial loads with line from southwest.
O. L.	Texas Empire Pipe Line Co.	Tulsa, Okla.	Okla. City, Okla.	East Texas	10-12"	250	Pur. right of way for oil line to East Texas
G. L.	United Public Service Co.	Houston, Texas	Austin	Wichita Falls	20"	240	Rumored plan extension of main line system.
G. L.	Wasatch Gas Company	Ogden, Utah	Ogden, Utah	Pocatello, Idaho	10"	140	Applied for permit to build welded line.
G. L.	Western States Utilities Co.	Tulsa, Okla.	(See Remarks)				Have tentative franchise in Carthage, Mo. Seeking others.

TABLE

O. L.—oil line Ga. L.—gasoline line
G. L.—gas line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The Month's Activities *in* Refining*

By F. R. STALEY

MANY refiners will install additional cracking equipment to manufacture high octane gasoline. Among those planning construction are Standard Oil Company of Indiana, The Sinclair Refining Company, The Empire Oil and Refining Company, and the Globe Oil and Refining Company.

The M. W. Kellogg Company is erecting a 20,000-barrel unit at Whiting for the Standard Oil Company of Indiana. This is a combination skimming and cracking unit that will produce a motor fuel above 70 octane number. Similar units of less capacity are being erected for the Standard Oil Company at Casper, Wyo., Wood River, Ill., and Sugar Creek, Mo.

During 1931 the gasoline recovered from crude showed 44.36 per cent, of this 24.65 per cent was straight run and 19.71 per cent was produced by cracking. The production of cracked gasoline has made rapid strides.

The Vickers Petroleum Company is building a 1,000-barrel refinery in Rice County, Kan.

The Mohawk Petroleum Company will build a 1,500-barrel refinery near Fruitvale, Calif.

The Thurber Earthen Products Company, subsidiary of the Texas Pacific Coal and Oil Company, have opened up a clay deposit near Woodward, Okla. A crushing and drying plant has been installed. The clay is especially suitable for contact filtration having a very high decolorizing and neutralizing value.

A symposium on the Chemical Engineering Processes in the Oil Industry was held during the Annual Meeting of the American Chemical Society in New Orleans. Dr. R. T. Haslam, of the Standard Oil Development Company, was chairman.

A report on the subject of Safety at Petroleum Cracking Plants is being prepared by the U. S. Bureau of Mines for early publication. A section of the paper will be devoted to the description of a tight-wire measuring apparatus for use in inspecting pressure and acid equipment in petroleum refineries. It makes possible the detection of portions of the equipment weakened by corrosion without further weakening the walls by drilling holes.

The A. S. T. M. Committee D-2 on Petroleum Products and Lubricants held its regular meeting March 8 in Cleveland in conjunction with the spring group meetings of committees. A new technical committee on Stoddard Solvent was formed and will function as technical Committee D.

Service Testing of Automotive Products and Correlation with Laboratory Tests were discussed at a joint meeting in Detroit of the A. S. T. M. and the Detroit Chapters of Automotive Engineers and the American Society of Steel Treaters.

The Mid-West Regional Meeting of the American Chemical Society will be held in St. Louis, May 5, 6, 7. A number of interesting papers on petroleum technology will be presented.

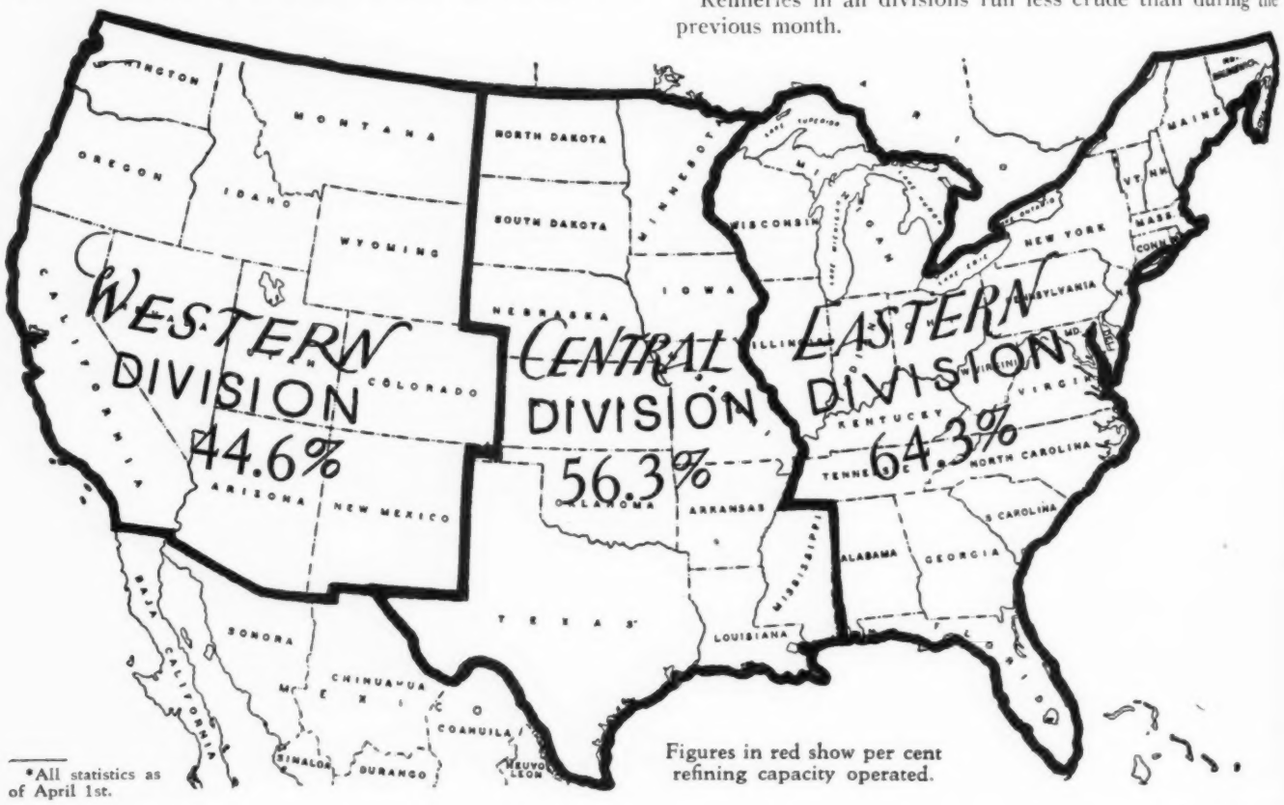
Natural Gasoline

The Natural Gasoline Association of America will hold the Annual Convention in Tulsa, May 17, 18, 19. The technical and economic problems of the industry will be discussed. Many important papers will be presented.

According to the Annual Petroleum Statement of the U. S. Bureau of Mines the output of natural gasoline declined for the second successive year. Production was 18 per cent below the year 1930. Nearly all the states and fields reported a decrease. The Kettleman Hills field was the only field showing a material gain in output in 1931.

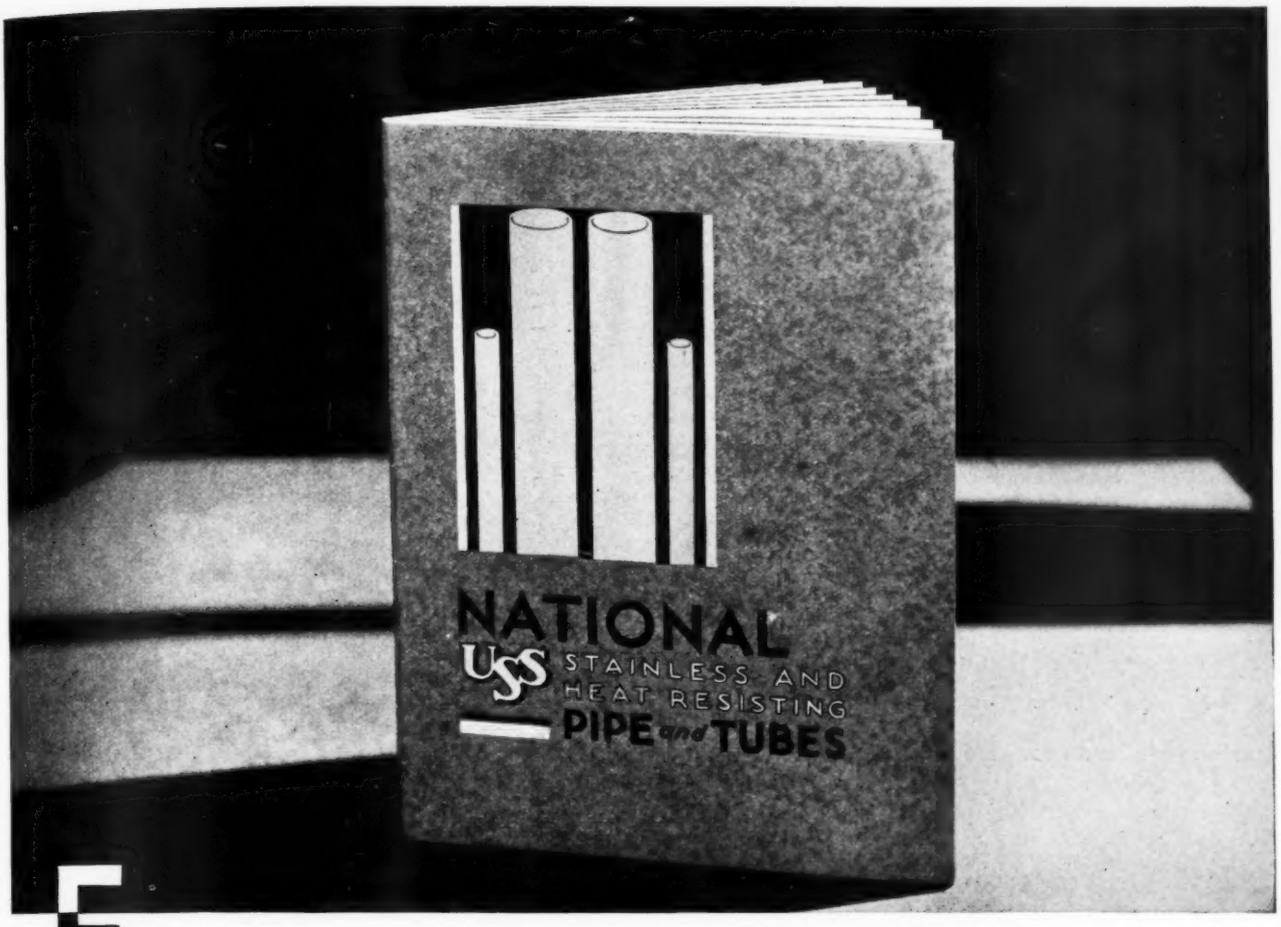
During 1931, Trinidad produced 85,876 barrels of casinghead compared with 6,026 barrels in 1930. The major part was transported by pipe line to refineries.

Refineries in all divisions run less crude than during the previous month.



Figures in red show per cent refining capacity operated.

*All statistics as of April 1st.



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Centrifugal Pump Packing

By HAL. T. WHEELER*

PREVENTING leakage by a packing on a rotating shaft is the problem of preventing an equilibrium between the circulation of liquid through the packing and the pressure impressed on the packing. There must be an excess of liquid at the side of the packing farthest from the source of pressure.

Packing on a rotating shaft is subjected as a general rule to a liquid of a definite quality at a constant pressure and the packing must react against a shaft rotating at a constant speed. All conditions are constant, except possibly the temperature of the liquid and the amount of heat created by the packing. However, before any serious consideration can be directed to the requirements of a packing to meet rotating shaft conditions, it is necessary to take up the conditions by which the packing will be measured.

Experience indicates that there are misunderstandings about the two simplest facts in the matter, and these are: That a rotating shaft is simple because it is made in a straight line, and that there is only one motion—that of rotation. A rotating shaft is so simply made and runs so smoothly that its actions are deceptive, not only to the eye and to the sense of feeling, but to the thought of the operator.

Centrifugal pump design is a move to attain simplicity of mechanical movements and to secure a constancy of flow of the material handled. It is true that many of the movements encountered in reciprocating pumps have been eliminated to advantage, but it is also true that other movements and relations are possible when a shaft rotates which were not present in other types, and that these may exist as a disadvantage to the packing. This is not to intimate that the disadvantages are a poor exchange, nor that they cannot be controlled; practice shows that they are not always being controlled within the necessary limits to give the packing the freedom it requires.

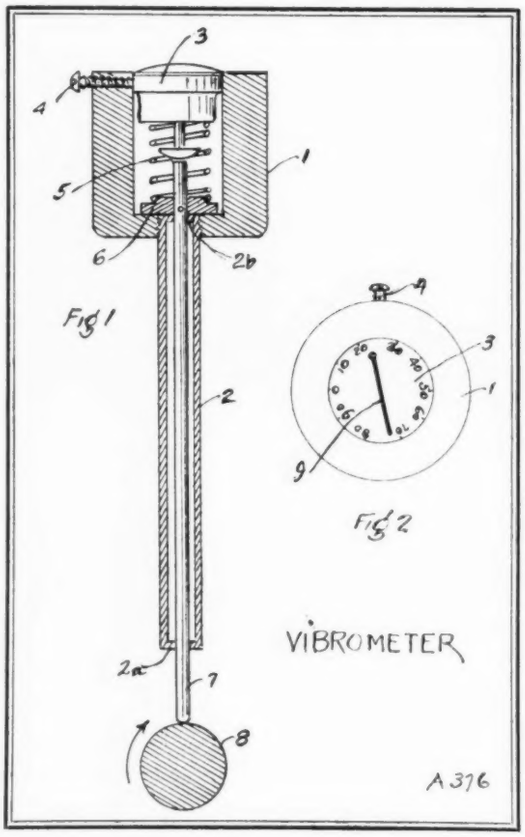
Centrifugal pump design leans toward simplicity; a straight shaft, constant rotation, a shaft floating on a film of oil of a constant thickness, a minimum of end motion, and a packing which is concentric with a shaft which is intended to move around a fixed center-line. The only drawback to this desirable simplicity is the fact that the packing gives far more trouble than any other part of the pump and is comparatively inefficient. That is to say, if the packing would do what is intended, the centrifugal pump would approach the ideal.

The reason for the failure of packing to keep step with the operating efficiency of the centrifugal pump design is easily defined: A difficulty in establishing a circulation through the packing to keep friction at a minimum, yet permit enough seepage to minimize cutting and keep the temperature of the sleeve and of the packing to a safe operating level. It would seem to be an easy matter to choose some packing which would meet the requirement. Yet, this is hard to do. It would appear either that the simplicity of the rotating design is only apparently so, or that some influences are at work against the packing, neutralizing what it is endeavoring to accomplish. The facts are that the trouble lies, in a measure, with both. To arrive at some conclusion as to where the trouble lies, a tabulation has been carried on over a period of years, a record of faults and troubles which have been removed before the packing would give its best performance. The table following includes work on steam turbine shaft packings of various kinds, and fibrous packings on centrifugal pumps handling liquids and gases (the geared impeller types excluded). Table number 1 shows the percentage of troubles encountered on shafts, 300 R. P. M. and above.

Item	Description	Percentage	
1	Eccentricity of sleeves	20.1%	
2	Bent shafts	8.1	
3	Balance	8.3	
4	Trembling of shafts	3.5	
5	Gyration of shafts	4.2	
6	Loose impellers	1.3	
7	Rubbing of diffusion rings	2.4	
8	Vibration of shafts, miscellaneous	10.1	
9	End play of shaft	8.0	
	Sub-Total		66.0%
10	Shafts off stuffing-box center	12.0	
11	Stuffing-boxes out of round	13.9	
12	Material of sleeves incorrect	8.	
	Sub-Total		33.9%
	Total		99.9%

It may be noted that the first nine items comprise two-thirds of the located troubles and that these occur from the lack of mechanical condition of the rotating element, the shaft and its impeller. The last three items refer to the frame or other influences and constitute but one-third of the corrections. It should therefore be evident that, despite mechanical simplicity, the rotating elements were the seat of most of the troubles. Further necessary information about the table is that nearly all of the corrections were needed after the first time the pump was overhauled, which indicates that it is apparently not so easy to duplicate the adjustments which the maker included during the process of manufacture.

A rotating shaft is supposed to spin around its mechanical center without deviation from the center-line established by machining the shaft. Unquestionably, if the shaft does rotate on this imaginary center-line, the packing problem would be simplified to juggling circulation and friction values, there being no outside



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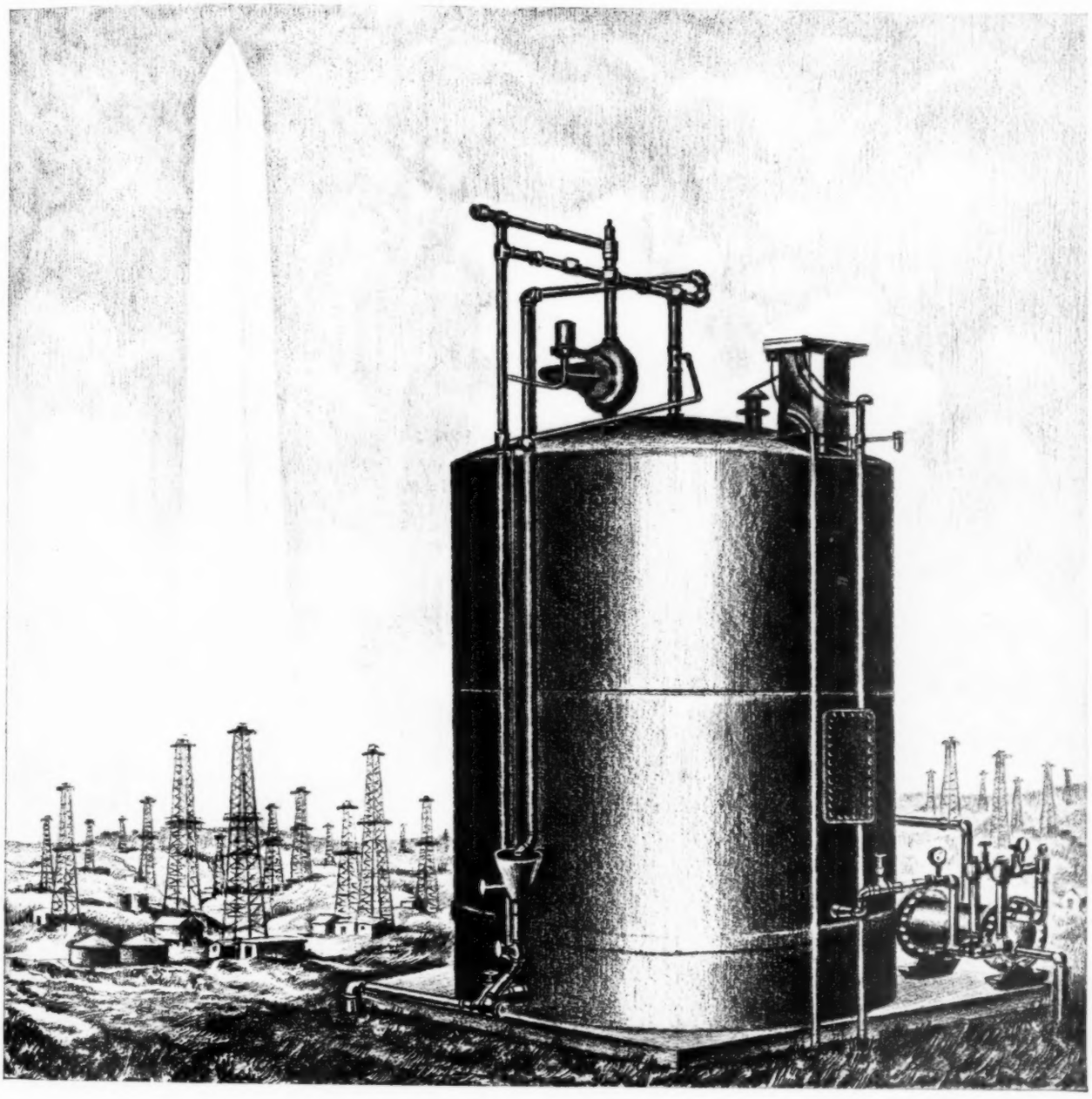

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influences. But until the interferences are known to be removed, centrifugal pump packing will remain an enigma. Fortunately, the problem of arriving at the condition of a rotating shaft is as simple as the shaft itself.

Referring again to Table 1, it may be seen that the first nine items may be expressed as a vibration, or movement off of the rotating center-line. And as the centrifugal pump usually rotates at a constant speed, the amount of vibration which can be measured at any instant will represent the operating condition over a period of time (the exceptions being items 4 and 5). Therefore, the vibration when measured is an expression common to the operating

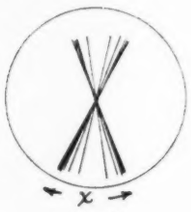

Fig 3

Fig 4

Fig 5

Fig 6

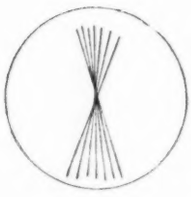
Fig 7

condition of the shaft and its impeller. When the surface of the shaft is traveling true, the imaginary center-line of the shaft is turning in the same place as the center-line of rotation. Any measured vibration, or deviation at the shaft surface, then is just twice the distance between the actual center-line of the shaft and the line about which the shaft is rotating.

While the condition of no-vibration is desirable, it is rarely found; a shaft rotating at high speed pulling an impeller delivering a load, does vibrate. It is then in order to state what are the reasonable and allowable limits of vibration that will permit the continual operation of packing. Table number 2 gives maximum allowable readings of the vibrometer, being the total swing of the pointer, and is based on revolutions per minute, applying to pressures per square inch at the packing not to exceed 50 pounds.

TABLE No. 2

R.P.M.	Inches	R.P.M.	Inches
300	.006″	1,800	.004″
600	.005″	3,600	.003″
900	.005″	7,200	.002″
1,200	.004″	10,000	.0015″

The foregoing table is presented as having given conservative, rather satisfactory results over a long period of time. And the reverse has been found to be true uniformly: Pumps which have operated consistently for long periods do not vibrate in excess of the values of this table.

But to digress from the subject of rotating shaft technicalities: Just how is the average operator going to benefit from a table expressed in thousandths of an inch? Granting that Table 2 is reasonable and that the conditions expressed are desirable, how is an operator whose measuring instruments usually consist of a 6-foot rule and a few calipers going to make any such comparisons? Judging from the usual reticence of everyone to make close measurements, it would seem that centrifugal pumps will continue to operate as they are doing. And yet it has been proven by those who have specialized on the subject that most of the operating troubles of packing are caused by a digression from the values of Table 2. Further observations are made which will finally lead to the explanation why these close measurements should be made, and the advisability of thinking in thousandths of an inch when tuning a centrifugal pump.

For example: On a slow-moving reciprocating rod, the travel off center during a stroke may be accurately gauged by the eye and a good opinion formed as to the capability of the packing to react against it and form a seal. But as the speed of the rod increases the eye cannot follow the variations in travel because it sees a haze of movement. Therefore, any opinion formed will be as inaccurate as the evidence presented to the eye. And the sense of touch is just as unreliable in judging the effects of high speed, for above a certain rapidity of impression, the nervous system will not discriminate. Although the eye and the nervous system vary according to the individual, it is certain the eye is the best judge of motion, even the results of instruments being appraised by the visible evidence they present.

As the simplicity of a centrifugal pump lies in economy of movement, rotation only being desired, casual examination by the eye will verify that this is the only movement. Yet the use of an instrument will define several different kinds of vibration. Such terms as vibration, gyration, trembling, end-play and the like are applied to what the instrument locates. The vibration proves to be an effect from a mechanical cause, which in turn becomes a cause to bring about further defects and derangements, especially as packing is concerned. To separate cause and effect in a series of rapid motions that neither the eye can perceive nor the senses appreciate is actually the work of an instrument, preferably a plain device that anyone can use and the interpretations of which will be self-evident. That is to say, the instrument must present a result which will take into account all of the technicalities, allow for them, and then give an expression which is direct.

Figure 1 introduces such an instrument, herein called a vibrometer. It is an ordinary machinist's dial indicator mounted in such a way as to react against any vibration and, while doing so, to measure the exact amount of movement in thousandths of an inch. The frame (1) is a cup made of cast iron and weighing about 2 pounds. The pipe (2) is about ⅛-inch standard and screwed into the bottom of the cup (1), and has two guiding points (2a and 2b) for free movement of the rod (7). The rod (7) is preferably a thin brass tube, the lower end in contact with the shaft (8) being tipped with red fiber. A collar (6) is pinned or soldered to the rod (7), so that when the dial indicator (3) is inserted in the cup (1) there will be about $\frac{1}{64}$-inch clearance between the rod (7) and the ball-face of the indicator shaft. A helical spring (5), slightly compressed between the back of the indicator and a boss on the collar (6), completes the assembly. A set screw (4) adjusts the position of the indicator (3). Figure 2 is a plan view of the device, showing the face of the indicator extending from the cup (1). The action of the pointer (9) is the basis of the comparisons to follow.

Figures 3 to 7, inclusive, are views of the dial indicator pointer (9) in action due to minute movements of a rotating shaft. The assembly of Figure 1 is held against a shaft, the cup (1) being gripped by the hand and pressure applied toward the shaft until the rod (7) contacts with the indicator shaft and moves the point (9) around the dial far

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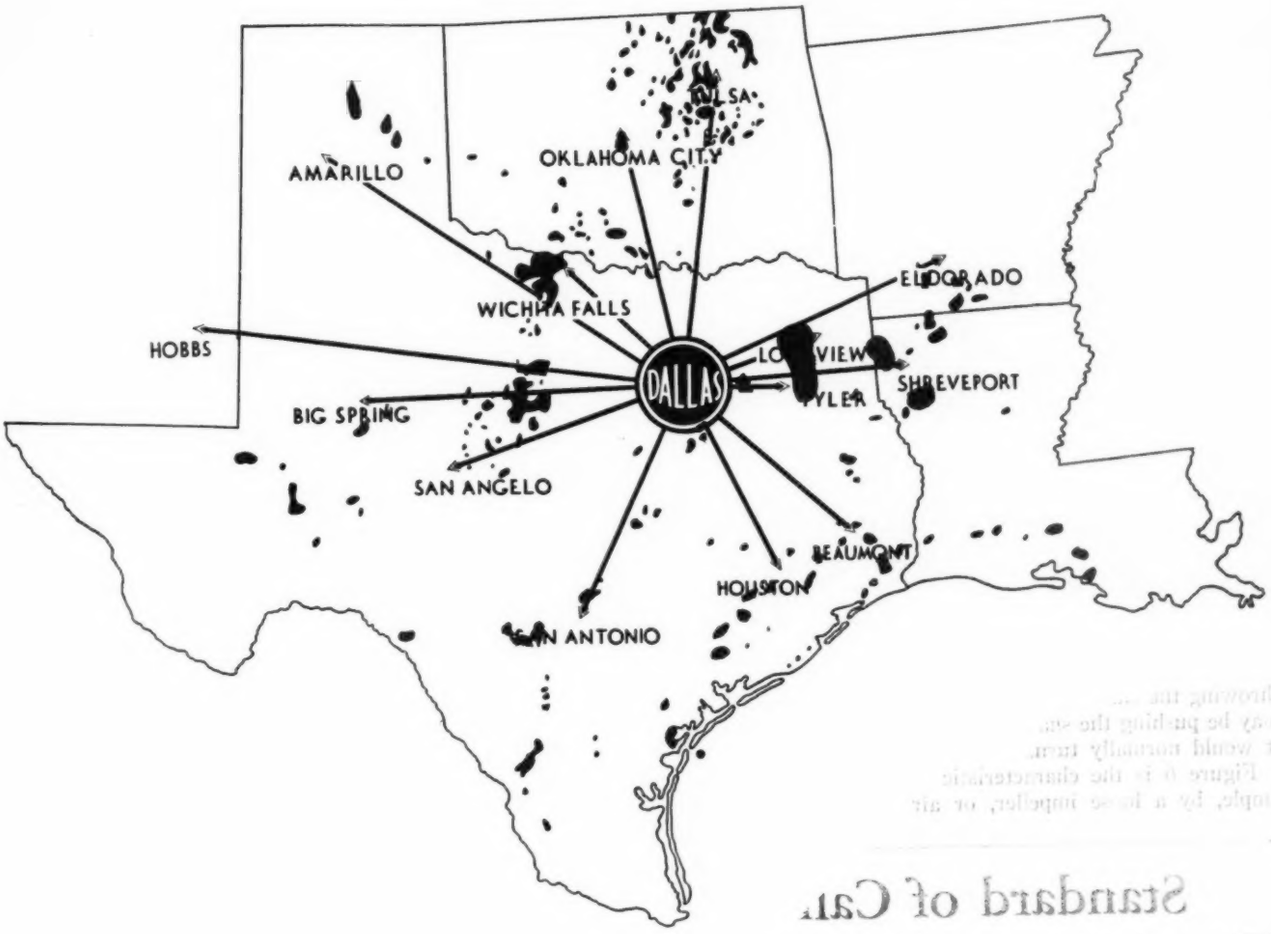

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enough so that it will not be disengaged by the clearance allowed during adjustment. The rod (7) is now floating between the shaft (8) and the spring (5). Any impulse imparted to the rod (7) will be resisted by the spring (5), tending to keep the rod against the shaft, and at the same time the small spring in the indicator will keep the ball-face end of its shaft against the rod (7), giving a direct reading on the dial by the pointer (9).

For slow movements the eye can follow the pointer. But during quick movements the pointer presents but a haze of movement which has a kaleidoscopic effect on the eye similar to a moving picture. As each kind of a vibrational movement has a characteristic, the movements themselves may be recognized by the conventional figures following.

Figure 3 is the characteristic of a straight shaft vibrating normally due to a slight unbalance, but not in degree sufficient to touch the housing or the side bearing clearances. Normal vibration is defined as a steady movement of the shaft back and forth. It occurs in greatest amount in a horizontal plane due to the side clearances of the bearings. In the vertical it will be found to be about one-half the horizontal reading, due to the shaft floating on the oil film. The distance (x) between the maximum swings of the pointer is the amount of movement and is read directly from the indicator dial.

Figure 4 is an excess of vibration by a straight shaft, the shaft striking the housing or bearing clearances slightly. The pointer will appear to stand still at both ends of the swing.

Figure 5 is the indication of gyration. The shaft is not only vibrating normally, but at the same time is traveling around the bearing surfaces in a circular path and not floating on the oil film. At some one point the pointer will show that the shaft hesitates. This may be due to bad balance, the shaft is bent, misaligned coupling bolts may be throwing the shaft off its rotative center, or other influences may be pushing the shaft away from the center about which it would normally turn.

Figure 6 is the characteristic of shock, caused, for example, by a loose impeller, or air caught in the impeller chamber. The shaft is violently jerked back and forth and usually stays at opposite diameters the longest time. But the shock of contact with the housing or bearing surfaces is transferred to the frame and the outside haze indicates that the pump frame is moving.

Figure 7 indicates a trembling shaft, in balance but too weak to rotate on one center-line. It will tremble slightly in all directions. The shaft may be too small, a crank may be forming, or, as in most such cases, the packing has worn through the sleeve and is reducing the shaft diameter.

The characteristics shown are but samples of the results to be obtained from rotating shafts running in babbitt or bushing bearings. Ball bearings, thrust bearings and other bearings have their individual reactions and the manipulator can quickly recognize them after some practice. The same instrument can be used on high-speed reciprocating rods, machine frames, pushed into inaccessible points where there is movement, to obtain the characteristic.

The main movement of a centrifugal pump is rotation. Contributory motions of vibration do exist, but are usually ignored. No one denies the existence of vibration, but the small amount of movement which must be measured in thousandths of an inch, the direction in which it occurs and the fraction of a second in which the changes take place seem to be such small quantities that they can hardly affect the running condition of a shaft. And when packing is considered, it is usually purchased to compensate for these movements, but as it consistently fails to do that, it appears that these details of vibration have much to do with the packing problem.

If the cost of instruments and the time necessary to check the pump were prohibitive, it would be advisable to run the pumps anyway to keep them going. But with the handy method outlined, whole batteries of pumps may be checked in a short period of time and information secured at once before trouble has developed, and an intelligent idea formed as to how any one pump is operating. This is the first step toward tackling the packing problem on a rotating shaft.

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Standard of California Rebuilds Old Refinery

THE Standard Oil Company of California recently reconstructed the ruins of a small oil refinery (forgotten in the undergrowth for a half a century) that represents the first successful attempt to manufacture products from petroleum in California. A two-inch pipe laid through the mountains from the oil wells, the first of which was drilled in August, 1875.

This conveyor represented the first oil pipe line in California.

...that time, kerosene marketed on the Pacific Coast was brought in from the Atlantic seaboard in casks and cases.

This successful refinery was the predecessor of the Standard Oil Company of California. G. G. Scofield and several San Francisco associates organized the company and acquired possession of property in Pico Canyon for this exploitation.

The crude oil was stored in tanks on the hill behind the plant from which it flowed by gravity through two two-inch pipes to the stills. The stills were fired with crude oil, also gravitated from the hillside and carried into the combustion chamber in a spray finely divided by a steam jet. When the stills were fired the vapors passed off in lead lines from the top and were condensed in a series of coils located in a wooden condenser trough on the hillside behind the plant. Steam was introduced at the top of the stills to prevent boiling over. Water was supplied to the condenser through and to the boiler from a natural spring located approximately two hundred feet up the canyon.

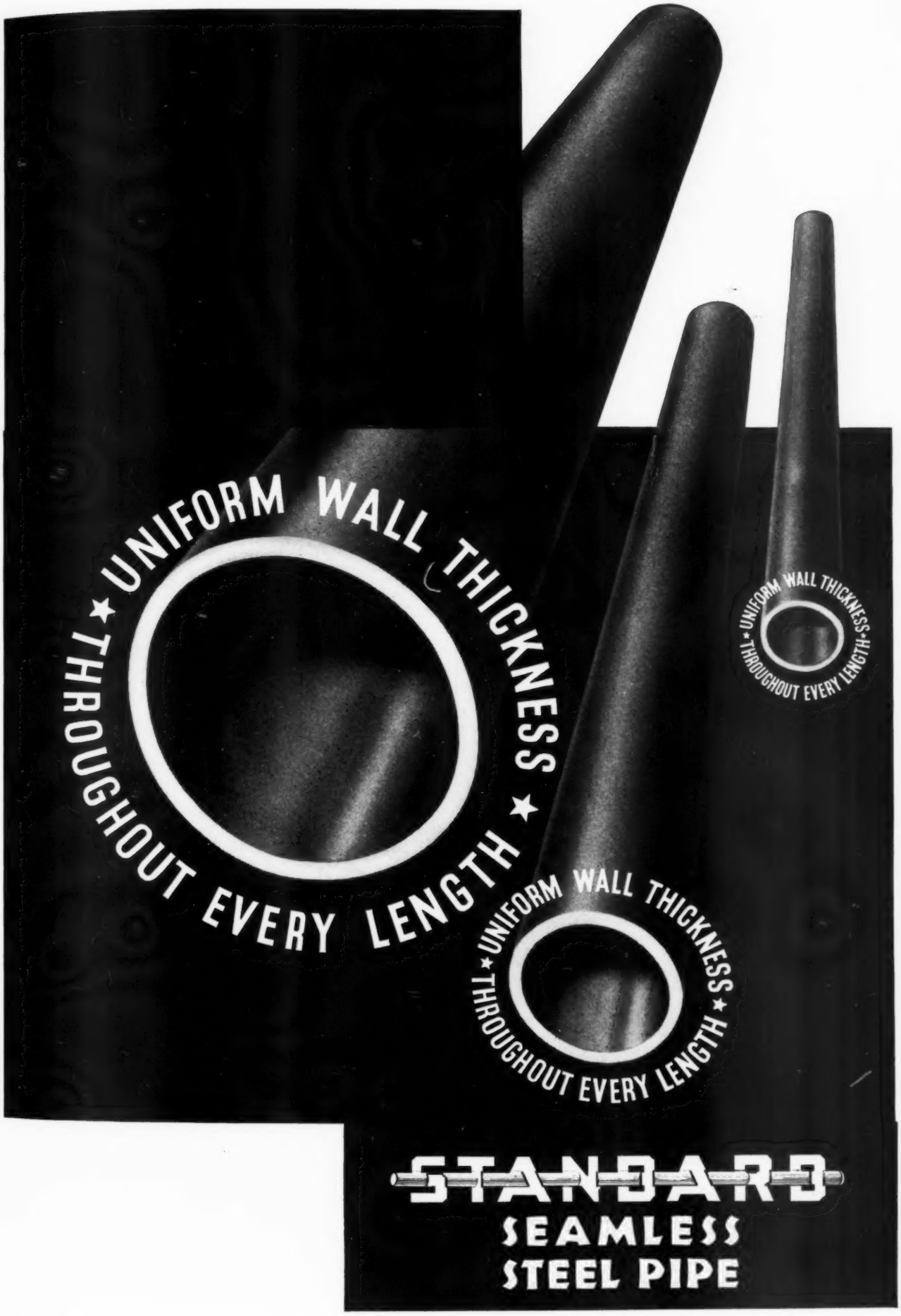
Old refinery after restoration.

The condensate was conveyed to headers located in a brick tail-house at the end of the condensing trough. There it spilled in an open stream into funnels, which served as look boxes, and was directed to the proper storage tanks.

The refined products ranged from a small amount of high-gravity (96°) so-called "benzine", through kerosene, to a lower-grade product termed "slop oil". A very small amount of lubricating oil was also made.

A bronze tablet upon the side of the center still reads:

California's First Oil Refinery, operated on a commercial scale, erected 1876-1878, restored by the Standard Oil Company of California in 1930, as a memorial to D. G. Scofield and his pioneer associates of the California Star oil works company, a predecessor of the Standard Oil Company of California, who procured in 1875-1876 California's first commercial production of crude petroleum in Pico Canyon, six miles northwest of this point, and built this refinery for the manufacture of petroleum products.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. . . Rigid Specifica tio Foundation and Ce at EAST TEXAS L

WHEN the Tidal Oil Company decided to drill a well on its Lake Devernia lease in the East Texas field, special consideration had to be given to the derrick foundation and cellar construction. In reality, this work of surface preparation before spudding in, was a more formidable task than the drilling of the well itself.

The location of this well, Lake Devernia No. 2 in the G. R. Rains, W. H. Hart, and N. G. Painter Survey, is in the Lake, 300 feet north of the center line of the Gladewater-Willow Springs highway and 208 feet from the mean shore line of the west bank of the Lake.

(Top to bottom): Rig builder fishing out top leg section of derrick that dropped in Lake. Mud Box 208 feet long can be seen in this picture. It is 24 inches on sides and bottom. Roadway out to the well. Water was four inches deep on the floor of the bridge. Note the boilers and mud pits entirely surrounded by water. Well was shut down more than two days, boilers could not be fired. Mud pits covered over with flood waters of Lake.

Designs and specifications for the derrick foundation and cellar construction were prepared by the Engineering Department of the Tidal Oil Company. A turnkey contract for the job was awarded to the Fox Rig and Lumber Company of Longview. It included a 208-foot roadway out to the well, putting in the complete derrick foundation, construction of a concrete cellar 16 feet or deeper as found necessary to obtain a solid footing, and the erection of the derrick. Specifications for the derrick foundation called for 12-pound, 40-foot creosoted yellow pine piles, 12-inch butts, natural taper. These were to be driven at least 10 feet into a solid bed. All piling was creosoted except that for the pipe rack. The required test for support was determined from the safe bearing power for a timber driven by gravity hammer as given by the formula:

$$L = \frac{2\ W\ h}{s + 1}$$

where L = safe load in lb.
W = weight of hammer in lb.
h = height of fall in feet.
s = average penetration in inches per blow for the last three blows.

This is known as the Iowa Bridge Formula.

For the derrick foundation, nine piles were driven for each derrick corner. By driving the piling with a 2800-pound hammer falling 22 feet, for an average penetration of two inches, a support of 1,368,000 pounds was obtained for the derrick foundation. As a Parkersburg 94-foot silicon steel derrick of 436,000-pound capacity was used, this gave a piling support with a safety factor 3.1 greater than derrick. Actually, the safety factor was somewhat greater than this on account of the extra piling supporting the base sills. The corner piling was not braced, but only capped with 12-inch by 12-inch by seven-foot creosoted timbers drifted together with ¾-inch pins, 24 inches long. All cap sills had a 13/16-inch hole for drift pin.

During the drilling of the well the piling had to support some very heavy loads. For example, while landing the seven-inch casing, a tremendous weight was carried, consisting of 3700 feet of four-inch drill pipe, about 3650 feet of seven-inch O. D. 24-pound casing, 200 sacks cement, tools, drawworks, crownblocks, and a full crew of men. Levels were therefore run on the derrick corners after the well was drilled to ascertain if the piling had settled. It was found that only one corner had settled ⅛-inch, the other three were level. Nor was there any evidence of weakness in the foundation. From this the conclusion is drawn that an unsupported length of 15 feet, using 9-pile corners, does not have to be braced.

High-water levels of the Lake and rainfall statistics for some years back were carefully studied to determine the minimum height of the derrick floor level so that at no time would it be under water. Whatever pains were taken to

tions Adhered to in Cellar Construction LAKE WELL

determine this level apparently were well worth while. Heavy rainfall, the greatest in the district in years, occurred while the work was well under way, and brought in its wake a record high rise in the Lake level that came to within 31 inches of the derrick floor; this despite the fact that the derrick floor level is 7.3 feet above the spillway of the Lake 4500 feet to the south. A 24-hour deluge of 4.72 inches fell on January 5, 1932, causing the water in the Lake to surge 5.2 feet above the spillway.

In constructing the cellar, a caisson 11 feet in diameter, was lowered to the bed of the Lake in two eight-foot sections, with a tar-paper, water-tight joint between the sections. It was centered and lowered into position by means of a frame directly over the well location. Circular forms, 11-feet and 8½-feet diameter, respectively, were placed inside the caisson in position for running the concrete. As now completed the cellar is 8½ feet in diameter with reinforced concrete walls about 18 inches thick. Construction of the cellar was begun November 24, 1931, and completed December 19, 1931.

After the cellar was completed, the surface conductor, consisting of a 26-foot length of 20-inch casing, was centered in the cellar and driven 8½ feet into yellow clay. An 8¼-inch connection is welded in the 20-inch near the top as an overflow for the drilling fluid. About three weeks after the cellar was completed the Lake reached its peak level and touched the top of the cellar.

Provision was made in the foundation for pumping equipment. In all, 18 additional piles were driven as supports for electric power equipment and a 6½-inch Lufkin Unit.

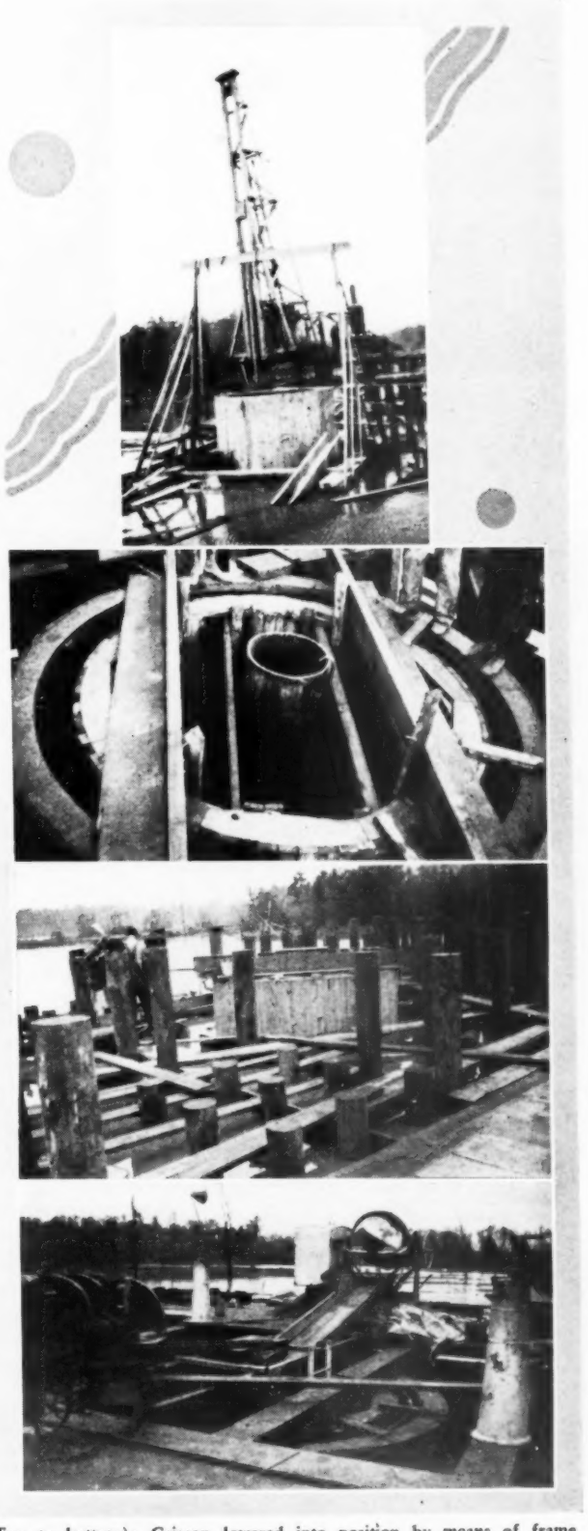
A sturdy structure had to be built for the roadway as it had to be strong enough to stand the trucking of drilling equipment and casing into the well. It consisted of three-pile creosoted bents driven 14 feet apart, and capped with 12-inch by 12-inch by 12-foot creosoted cap sills. Stringers, four-inch by 12-inch, were drifted to the cap sills with ¾-inch by 24-inch drift pins. The roadway was started November 20, 1931, and the floor completed December 17, 1931. A mud box, 24 inches on sides and bottom, 208 feet long, was built alongside the roadway.

Excavation for mud pits started November 22, 1931. These later had to be abandoned on account of high water and new ones started farther west on the bank of the Lake. A dragline was used to complete the excavation of the mud pits.

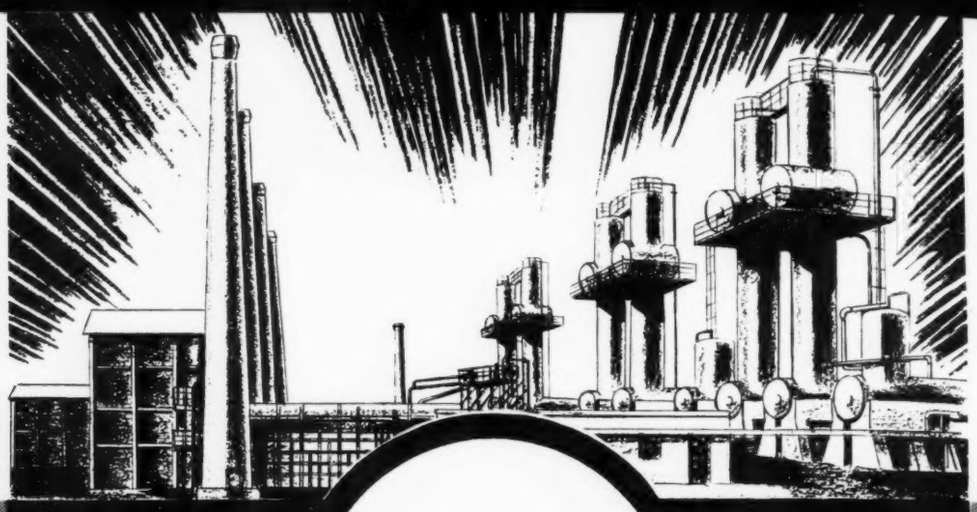
Photographs accompanying this article were taken while the construction of the derrick foundation, roadway, and cellar were in progress.

Drilling began December 31, 1931, and the well completed at a depth of 3532 feet, January 27, 1932. It was drilled with a string of four-inch drill pipe. Lake water was used for drilling. Work on the well had to be suspended two days because of high water. Besides the 26 feet of 20-inch conductor, 220 feet of 12½-inch, 50-pound casing, 3642 feet of seven-inch O. D. 24-pound casing, and 88 feet of 5⅞-inch perforated liner were run in the well. The 12½-inch and seven-inch casing were cemented with 100 and 200 sacks of cement, respectively.

On January 20, 1932, the well was placed on production and had an initial daily production of 5040 barrels oil through 2½-inch tubing. This was based on a 20-minute flow through the tubing. It has been estimated that this well has a potential open-flow through the casing of 25,000 barrels a day. It has also been estimated that the cost of this Lake well is $9,000 more than the cost of the average well in the East Texas field.



(Top to bottom): Caisson lowered into position by means of frame built over the location. Pile driver can be seen in position to drive another pile. Cellar forms in position for pouring concrete. In the center is the 20-inch conductor, which is driven 8½ feet into clay. It is 26 feet long. Nine piles for derrick corner cut off level, ready to be capped with 12-inch by 12-inch creosoted timbers. Preparing to run concrete for cellar. Note the carbide lights for night work when pouring concrete.



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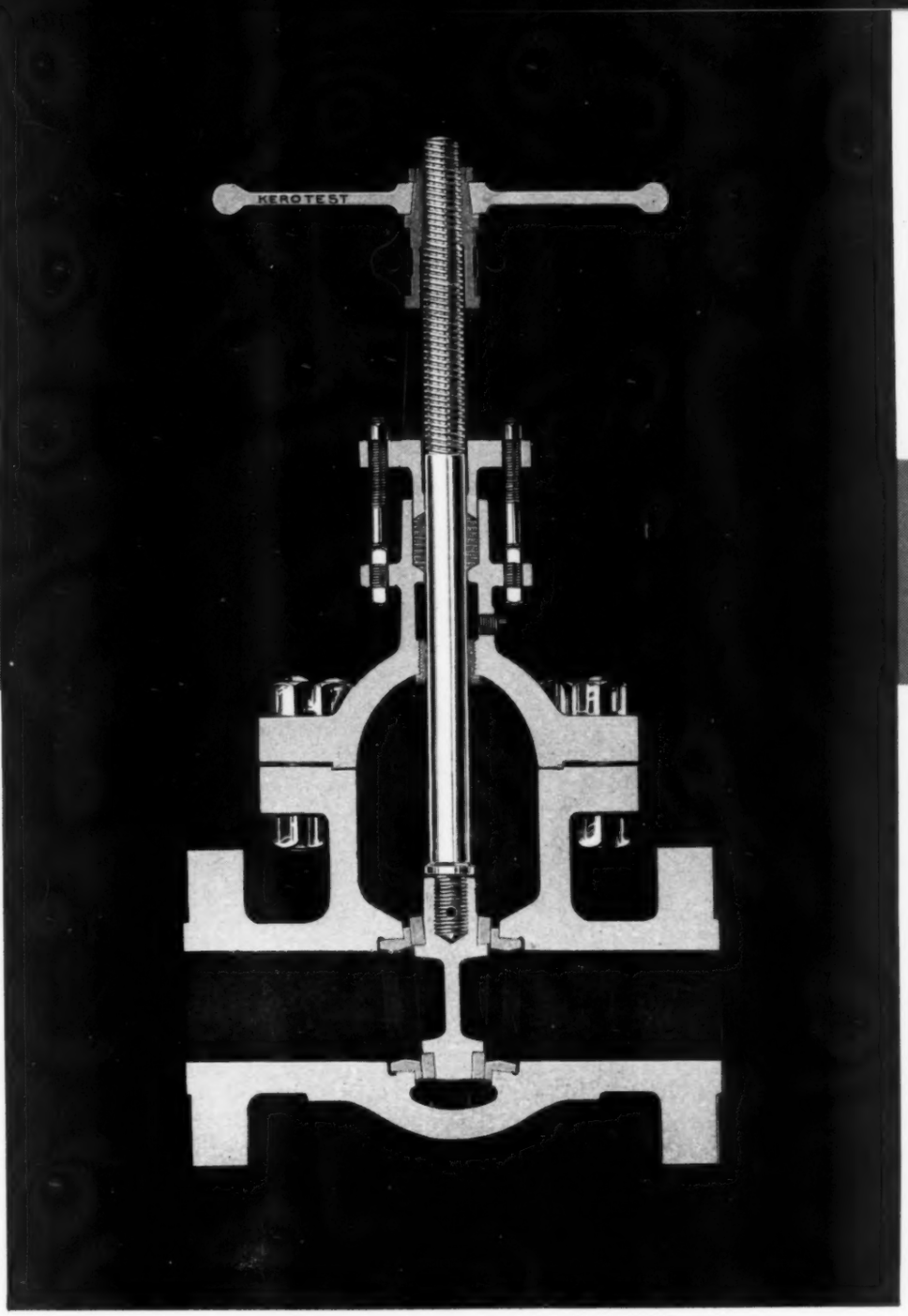

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Calculation of

Heat Balance for Gas Fired Boilers

By E. F. DAWSON[1]

THE following discussion takes up the method of calculating the efficiency and the heat balance of a gas-fired boiler. Because of the difficulties encountered with the usual method of calculation, the "Pound Mol" method, once understood, offers a much simpler and less confusing method of calculation for a boiler using a gaseous fuel. This method can, however, be used to good advantage for heat balance calculations for boilers using solid fuels.

The results of a heat balance calculation show at a glance, how the heat in the fuel has been utilized and where the losses have occurred. With this information available, the engineer can take steps to reduce the losses and thus increase the efficiency.

E. F. Dawson

The items that enter into heat balance calculations of a natural gas-fired boiler are shown below:

The unit on which the above heat balance is based is the heating value in British Thermal Unites (B. t. u.), of one pound mol of the natural gas used.

The items for a heat balance calculation for a solid fuel would include, besides the above, the heat loss due to the moisture in the fuel and the heat loss due to the combustible in the refuse.

From the observed test data the following totals and averages can be determined.

1. Water evaporated per hour in pounds.
2. Cubic feet of gas consumed per hour.
3. Barometric pressure in inches mercury.
4. Steam pressure, pounds per square inch gage.
5. Quality of the steam in per cent (if wet). Temperature of steam in degrees Fahrenheit (if superheated).
6. Temperature of the boiler feed. Degrees Fahrenheit.
7. Temperature of fuel for which meter is set. Degrees Fahrenheit.
8. Pressure of fuel for which meter is set. Oz. per sq. in. gage.
9. Boiler room temperature—Dry bulb, degrees Fahrenheit.
10. Boiler room temperature—Wet bulb, degrees Fahrenheit.
11. Flue gas temperature. Degrees Fahrenheit.
12. Flue gas analysis: CO_2——%, O_2——%, CO——%, N_2——%.
13. Fuel analysis by volume: CH_4——%, C_2H_4——%, C_2H_6——%, N_2——%, CO_2——%, O_2——%.
14. Heating value (higher). ——B. t. u. per cu. ft. at ——oz. per sq. in., ———F and ——inches mercury barometric pressure

As the calculation is to be based on one pound mol of fuel, it will be well to make some general remarks regarding this unit.

A "Pound Mol" of a substance is the number of pounds of this substance numerically equal to its molecular weight. One pound mol of all gases at the same temperature and pressure occupies the same volume.

Gaseous elements, mixtures and compounds are usually measured volumetrically. The transfer from the weight basis to the volume basis or vice versa is readily effected by the following application of Avogadro's law:

$$P\ v \div T = 1544 \div m \quad \text{(Eqn. 1)}$$

where P = pressure in pounds per sq. ft.
v = specific volume, or cu. ft. per pound.
T = absolute temperature (°F+460).
m = molecular weight of the gas referred to oxygen as 32.

The approximate molecular weights of various elements and gases are: Oxygen 32; Hydrogen 2; Nitrogen 28; Carbon 12; Carbon Dioxide 44; Carbon Monoxide 28; Methane (CH_4) 16; Ethylene (C_2H_4) 28; Ethane (C_2H_6) 30; Air 29.

The examples that follow are given for the purpose of illustrating the procedure in making the various calculations.

In order that the examples may be related, the following sample test data will be used for all the examples:

1. Water evaporated per hour, 27,900 lbs.
2. Gas consumed per hour, 34,000 cu. ft.
3. Barometric reading, 28.94 inches Hg. or 14.2 lbs. per sq. in.
4. Steam pressure, 150 lbs. per sq. in. gage.
5. Quality of steam at boiler outlet, 98 per cent.
6. Boiler feed water temperature, 210 degrees F.
7. Temperature of fuel for which meter is set, 60 degrees F.
8. Pressure of fuel for which meter is set, 8 oz. per sq. in. gage.
9. Temperature of boiler room, dry bulb, 80 degrees F.
10. Temperature of boiler room, wet bulb, 70 degrees F.
11. Flue gas temperature, 420 degrees F.
12. Flue gas analysis: CO_2——8.0%, O_2——6.4%, CO——0%, N_2——85.6%.

Item	B. t. u.	Percent
A. Heat absorbed by the water and the steam	———	———
B. Heat loss in the dry chimney gases	———	———
C. Heat loss due to incomplete combustion	———	———
D. Heat loss due to superheating the moisture in the air used for combustion	———	———
E. Heat loss due to the moisture formed from the combustion of the hydrogen in the fuel	———	———
F. Heat loss due to radiation, unburned hydrocarbons and that unaccounted for	———	———
Total	———	100%

[1]Asst. Professor of Mechanical Engineering, University of Oklahoma.

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13. Flue analysis by volume: CH_4——73%, C_2H_6——23%, N_2——3%, CO_2——1%.
14. Heating value of gas at ——60 F., ——14.7 lbs. per sq. in. abs., ——1100 B. t. u. per cu. ft.

ITEM A.

Heat Absorbed by the Water and the Steam.

It is this item that effort should be made to increase to the maximum. Item A as a per cent is the boiler efficiency.

Boiler room conditions of temperature and pressure are taken as the base, as all of the air for combustion exists at these conditions.

The volume of gas consumed per hour, as given above, is under meter conditions. To convert this volume to boiler room conditions, the following combination of Charles and Boyles laws can be used.

$$P_1V_1 \div T_1 = P_2V_2 \div T_2 \text{—(Eqn. 2)}$$

where P_1 = absolute pressure of the gas in the line near meter.

P_2 = absolute pressure of boiler room in same unit as P_1.

T_1 = absolute temperature of gas in line near meter (°F.÷460).

T_2 = absolute temperature of boiler room (°F.+460).

V_1 = volume of gas as determined from the meter (cu. ft.).

V_2 = volume of gas converted to boiler room conditions of temperature and pressure (cu. ft.).

Example 1. $14.7 \times 34{,}000 \div 520 = 14.2 \times V_2 \div 540$

$V_2 = 36{,}570$ cu. ft.

The volume of one pound mol under boiler room conditions is determined from equation 1, where "vm" is the value desired.

Example 2. $14.2 \times 144 \times v \div (80 + 460) = 1544 \div m$

or $vm = 407.5$ cu. ft. per pound mol.

Therefore, the number of pound mols of gas at boiler room conditions, used per hour = 36,570 ÷ 407.5, or 89.7.

The molecular weight of the natural gas can be determined by a weighted average of the fuel analysis and the molecular weights of the constituents of the fuel.

Example 3. The molecular weight of the gas equals

$$\frac{73 \times 16 + 23 \times 30 + 3 \times 28 + 1 \times 44}{100} = 19.86$$

The heating value of the gas per cu. ft. is 1100 B. t. u. at 60 degrees F. and 14.7 pounds per sq. in. absolute. The heating value under boiler room conditions can be obtained by knowing that the heating value per cu. ft. varies directly with the density. The density, in turn varies directly with the absolute pressure and inversely with the absolute temperature.

Example 4. The heating value of the gas under boiler room conditions equals

$$\frac{1100}{14.7} \times \frac{14.2 \times 520}{540} = 1023 \text{ B. t. u.}$$

The heating value per pound mol, or for 407.5 cu. ft. = $1023 \times 407.5 = 416{,}900$ B. t. u.

This value of 416,900 B. t. u. is the unit for the heat balance, or 100 per cent.

The pounds of water evaporated per pound mol is obtained:

Example 5. Pounds of water evaporated per pound mol of fuel equals

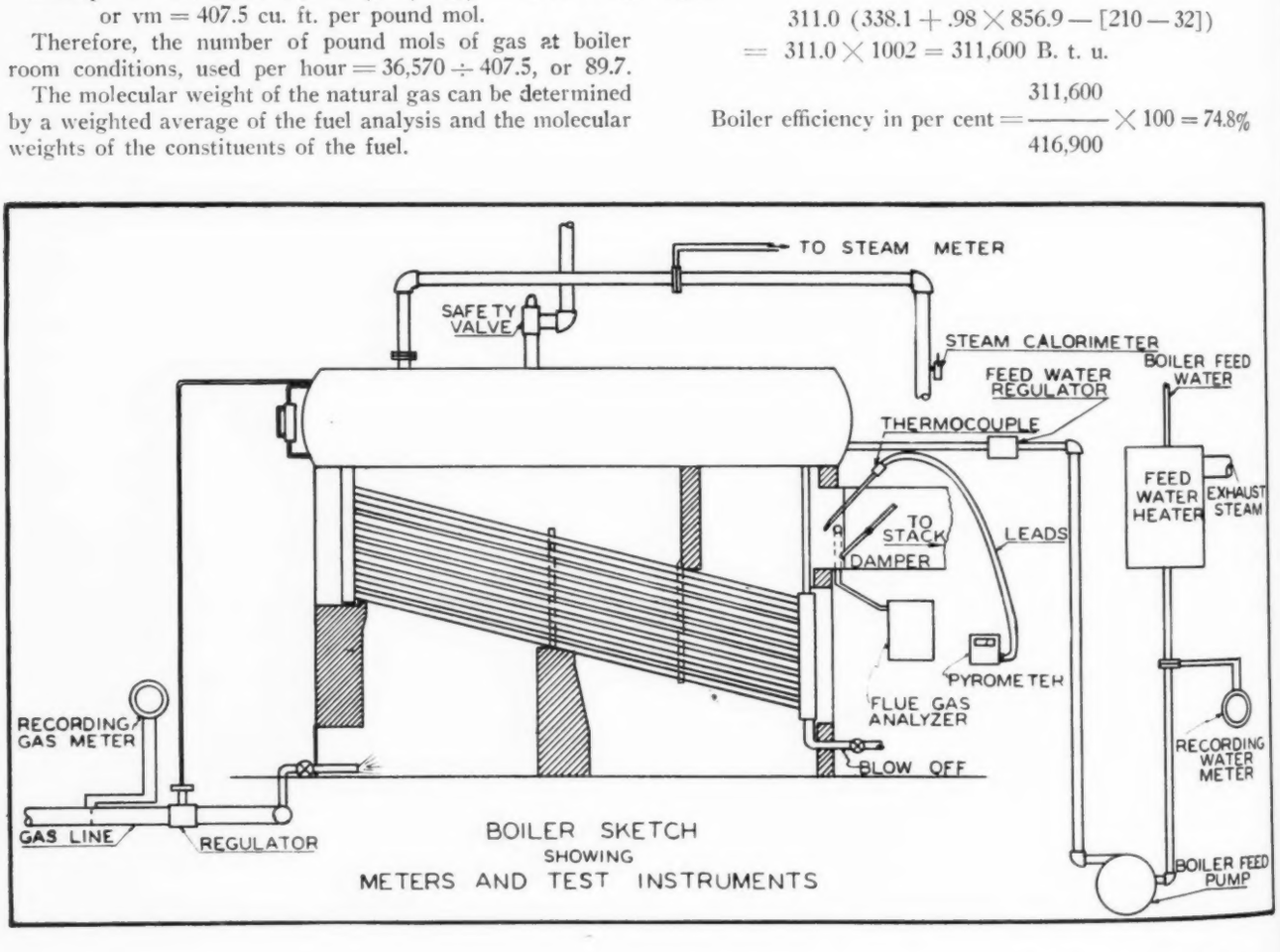
$$27{,}900 \div 89.7 = 311.0$$

The heat absorbed by the boiler per pound mol of fuel is obtained by multiplying the heat absorbed by each pound of boiler feed water by the number of pounds of water evaporated per pound mol of fuel.

Example 6. The B. t. u. absorbed per pound mol of fuel equals:

$$311.0\ (338.1 + .98 \times 856.9 - [210 - 32])$$
$$= 311.0 \times 1002 = 311{,}600 \text{ B. t. u.}$$

$$\text{Boiler efficiency in per cent} = \frac{311{,}600}{416{,}900} \times 100 = 74.8\%$$



BOILER SKETCH
SHOWING
METERS AND TEST INSTRUMENTS

Natural Gasoline Plant Flexibility

By ANSON W. DWEN, *Crosbie and Moran, Inc.*

DUE to the low cost aim of all gasoline plant production, brought about by the low price received for natural gasoline and the present decreased production, and the result of the proration schedules now in effect, it has been necessary to improve on the elasticity of all equipment installed both in the plants and in the field.

With the present proration schedules we have found it increasingly difficult to procure raw gas for the plants as practically all of the producers are mainly endeavoring to keep the water pumped from their wells which produce a considerable amount of water along with the oil. Some producers, however, have taken the attitude that the quicker they produce their allowable the more economical the cost of oil production. This may be true, but what a burden for the gasoline industry! The first part of the month, a good volume of gas for the plant and a resultant good production, and the remainder of the month a struggle to process enough gas to operate their plants economically so as to keep them from having to shut down. A shut down plant causes no end of expense both to the plant operator and to the producer, who either has to install combination connections on his lease to utilize the green gas for normal lease operations or has to purchase gas from some outside source.

With the decrease of casing-head gas to the plants, it was found necessary to devise methods of taking all available gas from the lease equipment, such as flow tanks, treating tanks and storage tanks. The superintendent of the St. Louis, Oklahoma plant, Robert Dwen, designed and had constructed the gas fitting shown in Figure 1. This fitting is installed on the oil inlet to either flow tanks, treating tanks, or oil storage tanks.

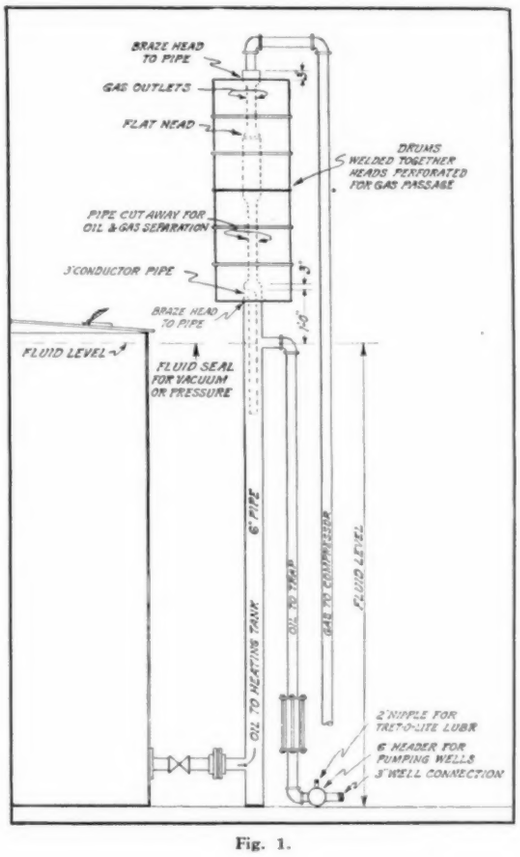


Fig. 1.

This type of gas fitting is constructed of two cylinders which have been welded together, and the neighboring heads perforated for gas passage. Through the center of these barrels has been welded a six-inch pipe which has been cut away for the gas passage and divided so as to prevent the plant vacuum from pulling directly through to the oil level. The bottom of this six-inch core has an inner three-inch pipe so welded as to act as a conductor for the separated oil flow down into the column below the oil inlet line. At the bottom of this oil inlet line is a header for the flow lines from the various wells on the lease. This header also has a connection for the injector of the oil treating fluid into the combined flow of all the wells. The top end of the core in the barrels is connected to the plant field gathering lines.

A gas fitting of this type is installed on the Westheimer and Daube, Freid lease in the St. Louis field. The construction of this type fitting is essentially the same as the sketch with the exception that six-inch pipe is substituted for the barrels and four-inch pipe for the six-inch columns.

A standard meter installation is used in the hook-up. The advantages derived from this type of hook-up are:

(1) During the flush production of the lease, two regulators, smaller size than the meter setting may be installed with an insurance of more sensitive control.

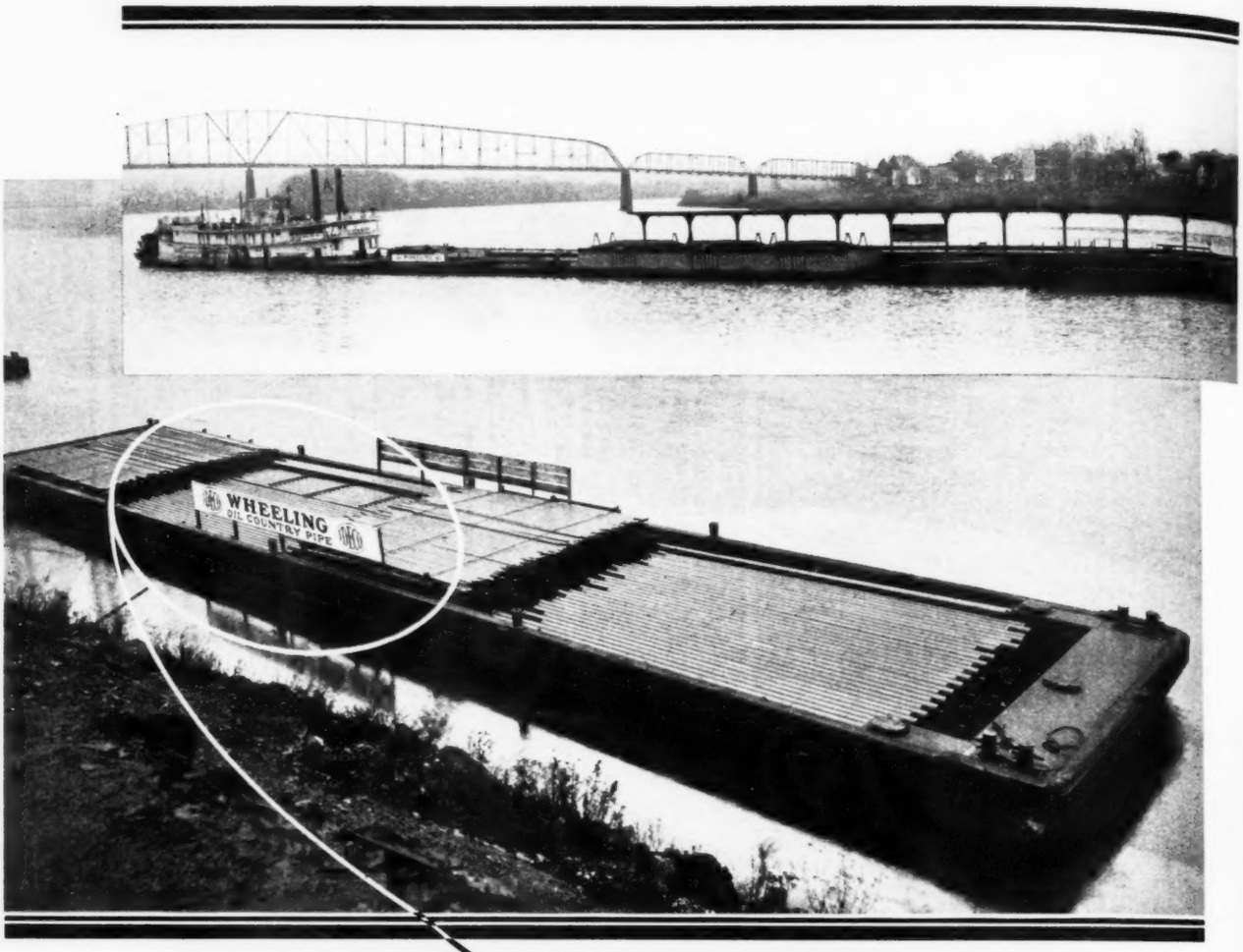
(2) During the flush production of the lease, one regulator and a gate may be installed, operating the gate so as to practically handle the volume with the gate and allowing the regulator to control the vacuum or pressure that is desired.

(3) After the flush production is over, one side of the installation may be plugged and the control handled with the remaining regulator.

(4) Then while there is still considerable volume of gas on the lease, and yet such a small volume that the original regulator is too large for efficient control, a smaller regulator may be installed.

(5) When the volume of gas from the lease has dropped to the point where the original meter setting is too large to accurately record the volume, the setting complete may readily be removed and a smaller setting installed.

From the above advantages, the flexibility and the ultimate economy of this type of meter installation may be readily realized.



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ITEM B.

Heat Loss in the Dry Chimney Gases.

The heat loss of the dry chimney gases per pound mol of fuel can be calculated from the following formula:

$$Hb = W\ Cp\ (tc - tr)$$

Where:

W = The weight of the dry chimney gases in pounds per pound mol of fuel consumed.

Cp = Mean specific heat of the chimney gases at constant pressure. (Usually taken as .24)

tc = Temperature of the chimney gases, °F.

tr = Temperature of the boiler room, °F.

Obtaining the value of "W" in the above formula necessitates the following discussion on the theoretical and actual combustion of natural gas. In order to illustrate the discussion, an example using values from the above data will be included.

Theoretical Combustion.

Example 7, and Discussion.

The approximate composition of air by volume is nitrogen 79 per cent and oxygen 21 per cent. Therefore, the value used in the following equation (3.76) is the ratio of nitrogen to oxygen in air or 79 ÷ 21.

The theoretical combustion equation for methane (CH_4) including the nitrogen that was in the air which furnishes the oxygen for combustion is:

$$CH_4 + 2O_2 + 2(3.76)N_2 = CO_2 + 2H_2O + 2(3.76)N_2$$

Mols.	1	2	7.52	1	2	7.52

(Eqn. 3)

or when one mol of CH_4 is burned, the dry chimney gases consist of one mol of CO_2 and 7.52 mols of N_2. When one mol of fuel is burned (of the above analysis) the dry chimney gases consist of .73 (.73 × 1) mols of CO_2 and 5.49 (.73 × 7.52) mols of N_2 from the CH_4 part of the fuel.

A similar theoretical equation for ethane (C_2H_6) is:

$$2C_2H_6 + 7O_2 + 7(3.76)N_2 = 4CO_2 + 6H_2O + 7(3.76)N_2$$

Mols.	2	7	26.32	4	6	26.32
or	1	3.5	13.16	2	3	13.16

(Eqn. 4)

or when one mol of fuel of the above analysis is burned, the dry chimney gases consist of .46 (.23 × 2) mols of CO_2 and 3.027 (.23 × 13.16) mols of N_2 from the C_2H_6 part of the fuel.

In summarizing, the theoretical amount of dry stack gases per pound mol of fuel of the above analysis is:

CO_2: .73 + .46 + .01 = 1.20 mols.

N_2: 5.49 + 3.03 + .03 = 8.55 mols.

Should the fuel contain ethylene (C_2H_4) or carbon monoxide (CO), their respective theoretical combustion equations are as here noted:

$$C_2H_4 + 3O_2 + 3\ (3.76\ N_2) = 2CO_2 + 2H_2O + 3(3.76\ N_2)$$

$$2CO + O_2 + (3.76\ N_2) = 2CO_2 + (3.76\ N_2)$$

Due to the impossibility of thoroughly mixing the fuel and the air in the combustion chamber, it is necessary to supply an excess of air for combustion.

The per cent of excess of air (%Xs Air) can be determined by the following formula. This formula should be used only for those fuels which are low in nitrogen content.

$$\%\text{Xs Air} = \frac{(O_2 - CO)/2}{N_2 \times 21/79 - (O2 - CO)/2} \times 100$$

where O_2, CO, and N_2 are in per cent as determined by the flue gas analysis.

The total number of mols of dry chimney gases per mol of fuel, for an excess of air, is:

(v) = Number of mols of CO_2: same as for theoretical combustion.

(u) = Number of mols of N_2:

$$(5.49 + 3.03 \frac{(100 + \%\text{Xs Air})}{100} + .03 = 1.20$$

(x) = Number of mols of O_2:

$$[(2 \times .73) + (3.5 + .23)] \frac{(\%\text{Xs Air})}{100}$$

If there is any CO in the dry chimney gases as indicated by the flue gas analysis, the number of mols of CO_2 as given above per mol of fuel should be corrected. The value of 1.20 mols of CO_2 assumes that all the carbon in the fuel was completely burned. With CO present in the flue gases, the mols of CO per mol of fuel is determined by multiplying its proportional in the flue gases by the sum of the mols of CO_2, N_2, and O_2 per mol of fuel as determined above. Or, the mols of CO per mol of fuel equals:

$$(y) = [(v) + (u) + (x)] \times (\%CO \div 100)$$

The mols of CO_2 corrected for the CO are equal to:

$$(z) = (v) - (y)$$

The sum of the mols of dry chimney gases per mol of fuel multiplied by the molecular weight of the flue gas will give the pounds of dry chimney gases per mol of fuel, or "W".

The molecular weight of the flue gas is calculated by the weighted average method.

Example of Item B calculation using the above data:

$$\%\text{Xs Air} = 6.4 \times 100 \div [(85. \frac{6x21}{79}) - (6.4)] = 39\%$$

(z) = 1.20; (u) = 11.84; (x) = .88; (y) = O

1.20 + 11.84 + .88 = 13.92 mols of dry gas per mol of fuel.

The molecular weight of the dry flue gas equals:

$(8.0 \times 44 + 6.4 \times 32 + 85.6 \times 28 \div (100) = 29.54$

Hence: Hb = (13.92 × 29.54) (.24) (420 — 80) = 33,560 B.t.u. or in per cent: 33,560 × 100 ÷ 416,900 = 8.0%.

ITEM C

Heat Loss Due to Incomplete Combustion

The heat loss due to the presence of carbon monoxide in the flue gases is determined as follows: The heating value of CO per pound is 4,354 B.t.u. or per pound mol, (4,354 × 28) 121,900 B.t.u. The mols of CO per mol of fuel [see (y)] multiplied by 121,900 gives the heat loss due to incomplete combustion.

SUMMARY

Item	Loss	B.t.u.	Per Cent
A.	Heat absorbed by the water and steam	311,600	74.8
B.	Heat loss in the dry chimney gases	33,560	8.0
C.	Heat loss due to incomplete combustion	0	0.0
D.	Heat loss due to superheating the moisture in the air used for combustion	910	0.2
E.	Heat loss due to the moisture formed from the combustion of the hydrogen in the fuel	46,600	11.2
F.	Heat loss due to radiation, unburned hydrocarbons and that unaccounted for	24,230	5.8
	Total	416,900	100%

Use *of* Single Cylinder Engines *for* Driving Geared Pumping Units

By J. C. GORDON, *Production Engineer, Fort Worth, Texas*

DEVELOPMENT of new oil fields with the prices of crude oil now prevailing demands that the cost of pumping installations be kept within reasonable figures.

An experiment has been made in an old field, which is of particular concern to those interested in heavy pumping equipment. A 40-horsepower, single-cylinder, two-cycle gas engine was connected directly to and drove a geared pumping unit on a well producing 750 barrels of fluid per day, from a depth of 3000 feet. The practicability of this combination of equipment is of importance to those operators contemplating the installation of pumping equipment who have geared units, and gas or oil engines available for use.

The well selected for the test is 3000 feet in depth, and is equipped with 2½-inch tubing and ¾-inch sucker rods. The original pumping equipment, consisting of a 30-horsepower, single-cylinder, two-cycle gas engine driving a standard rig with a 12-foot bandwheel was retained at the well for emergency use and for testing.

The new equipment for the test was installed at right angles to the old standard rig. The engine used was a 40-horsepower, single-cylinder, two-cycle gas engine, equipped with heavy flywheels weighing 2000 pounds each. According to the manufacturer's rating, this engine is capable of developing 52 B. H. P. at 180 r. p. m. and 63 B. H. P. at 250 r. p. m.

The geared unit was of the worm gear, single reduction type, fitted with gears giving a reduction ratio of 11.3 to 1.0, at an engine speed of 250 r. p. m. The pumping strokes of the unit are 22.1 per minute. The counterbalance used was of the rotating type, attached to the crank. The gear had attachments for driving a chain-driven tubing hoist set beside the sampson post. Heavy steel sampson post and walking beam were used.

The unit was installed early in 1930 and operated for more than a year. On account of increased fluid handled from the well a heavier unit was then installed. The 40-horsepower engine had such an excess of power over the requirements for this well, that a smaller engine was installed when the unit was changed. This article refers to the original test installation only.

After the roustabouts became accustomed to handling rods and tubing with the hoist, they were able to make excellent time. This increase in speed was partially due, however, to the larger engine with the unit. The total fluid handled increased from 670 barrels per day for the standard rig to 750 barrels for the unit due to an increase in pumping speed of two strokes per minute. Of this fluid, 730 barrels was water, and 20 barrels oil.

After the unit had been operating for several weeks, special tests were made to ascertain the magnitude of stresses transmitted to the rods on account of the explosion impulses, and variations in speed, of the gas engine.

The special equipment used for the tests was a Katzenstein Torsiograph, a Martin-Decker Pump Dynamometer, a Maihak Continuous Engine Indicator, an indicating tachometer, and a test gas meter. During the test three types of flexible couplings were used for connecting the engine and unit. The first coupling used consisted of sets of thin resilient springs connecting an inner hub to an outer hub flange. This coupling allowed two degrees torsional variation. The second coupling consisted of a set of splines, or gear teeth, on flanges at the ends of the shafts to be connected, meshed with splines in two outer rings which are a part of a floating sleeve which houses the coupling. A torsional variation of one-half of one degree was permitted by this coupling. The third coupling used consisted of four heavy multiple leaf springs, extending from an inner driven hub flange to an outer housing which is part of the driven hub flange. The torsional variation can be changed by using springs of different strengths.

The Katzenstein Torsiograph was used to determine the torsional variation in the shafts under study. The motion of the shaft was transmitted to a pulley of the torsiograph by a cloth belt. A flywheel within this pulley is driven by a carefully calibrated volute spring. The flywheel tends to rotate at a constant angular velocity while the pulley rotates at an angular velocity corresponding to that of the shaft under study, to which it is belted. The difference between the velocity of the flywheel and the pulley is recorded on the moving chart or continuous card by means of a system of levers and a recording pen. An electrical timing device was set to indicate complete revolutions by marking the card. The record on the cards is very irregular, the peaks at the bottom of the curve indicate acceleration, the peaks at the top deceleration. The r. p. m. fluctuation is the difference in revolutions per minute from that represented by the deceleration and the acceleration peaks. Then the coefficient of fluctuation is the r. p. m. fluctuation divided by the average speed expressed in a fraction, the numerator of which is one.

The dynamometer was used to determine the load upon the polished rod, in the usual manner.

The engine indicator was used to determine the indicated horsepower of the gas engine, the test gas meter to measure fuel consumption. The tachometer gave the speed of the engine or any part of the equipment.

Records from the torsiograph are so accurate that engine explosions can be traced on the cards. The effect of engine impulses is diminished by the heavy flywheels of the engine as the kinetic energy stored in the flywheels is directly proportional to the weight and varies as the square of the speed. This is shown clearly by the coefficients of fluctuation obtained, three of them are as follows: At 22.1 strokes 72-inch, engine 250 r. p. m., coef. of fluc. 1/387; at 15.9 strokes 42-inch, engine 180 r. p. m., coef. of fluc. 1/328; at 11.76 strokes 32-inch, engine 133 r. p. m., coef. of fluc. 1/273—at the latter speed the crank could be seen to accelerate with each explosion in the engine.

The three types of couplings gave the same coefficient of fluctuation for the crankshaft at the speed of 22.1 strokes per minute, 72 inches in length, 250 r. m. p. of engine.

Curves were plotted from the dynamometer cards taken

from the polished rod and the torsiograph cards, and a graphic representation of the motion of the polished rod with respect to the motion of the crankshaft of the unit was drawn. Torsiograph cards were chosen representing conditions to be studied and the peak acceleration and deceleration points for each fluctuation determined. These points were transferred to crank motion and in turn to polished rod motion. In doing this it was assumed that all the velocity fluctuation was transferred from the crankshaft to the polished rod. This was a very liberal assumption as a great deal of this fluctuation would be taken up in deflection of the walking beam, elongation of the pitman, in the hanger, etc.

From these velocities, the time interval between a deceleration and acceleration peak, and the load on the polished rod, the force due to acceleration was calculated. For the gas-engine driven unit operating at twenty-two 72-inch strokes per minute, the maximum force due to acceleration from engine impulse was 31.6 pounds. This force is so small that when delivered to the polished rod the effect upon the rods is negligible.

By the same process calculation was made of the force due to acceleration delivered to the polished rod of another well which will be designated as well No. A-9. This well was equipped with a geared unit similar to the one studied at well No. 24, but an electric motor furnished the power. The well was the same depth as No. 24, equipped with 2½-inch tubing, ¾-inch sucker rods, and produced 800 barrels of fluid, practically all water, every 24 hours. The speed variations were greater on the motor-driven outfit, but the time between intervals was also greater, and when the force due to acceleration was calculated it was found to be practically the same as for the gas-engine driven unit on well No. 24. If a small flywheel were installed on the shaft between the motor and the unit much steadier operation would be obtained. Owing to the high speed of the motor this flywheel would not have to be of large diameter, the high rim velocity would also prohibit a large diameter.

A study was made of the gas engine driven standard rig at well No. 24. At a 72-inch, 20.3 strokes per minute pumping speed, the well was producing 672 barrels of fluid per day. Calculations of the force due to acceleration delivered to the polished rod at the speed mentioned showed a maximum force of 215 pounds would be delivered to the polished rod. This force may have an effect upon the rods.

The engine in this standard rig output was operating at 162 r. p. m. Torsiograph cards were obtained from the engine, and from the clutch shaft in addition to those taken from the crankshaft of the bandwheel.

Torsiograph cards were taken in the same manner on a well designated as well No. 28-1 in the Van field of East Texas. This well was equipped with a single-cylinder, two-cycle, 40-horsepower gas engine with 2000-pound wheels, driving a steel standard rig that had a 12-foot bandwheel, approximately 3000 feet of 2½-inch tubing and ¾-inch sucker rods.

A study of the torsiograph cards from the engine, clutch, and bandwheel shafts of the standard rigs at wells No. 24 and No. 28-1 showed that although the coefficient of fluctuation of the engine and clutch shafts was greater than that of the bandwheel shaft, the fluctuation of the bandwheel is found to be greater than that of the clutch when the variations in speed are laid out on the circumference of the drive pulley and bandwheel. For example:

Well No. 28-1 at 32-inch stroke, 15.4 per min., engine 123 r. p. m.

Arc of 1/134.5 fluct. on 12 ft. bandwheel rim = 3.35 inches

Arc of 1/27.9 fluct. on 18 in. clutch pulley = 2.025 inches

Belt stretch or slip = 1.33 inches

Well No. 24 at 72-inch stroke, 20.3 per min., engine 163 r. p. m.

Arc of 1/64.5 fluct. on 12 ft. bandwheel rim = 7.01 inches

Arc of 1/14.3 fluct. on 18 in. clutch pulley = 3.95 inches

Belt stretch or slip = 3.06 inches

It is evident that the load affects the fluctuations of the bandwheel speed on the standard rig quite materially. The difference between the pumping speeds of the two standard rigs tested is so great that no conclusion can be drawn from these tests as to the result of using heavier flywheels on the engines driving standard rigs.

Gas engine-driven pumping unit at well McKie No. 24 in the Van pool of East Texas.

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Selection *and* Handling *of* Grease Plant Raw Materials

DR. WM. T. SIEBER, *Chief Chemist, Waverly Oil Works, Pittsburgh, Pa.*

TO promote the efficient and successful operation of a grease plant it is, just as in any other line of manufacture, of utmost importance to use great care and good judgment in the selection and handling of the raw materials entering into the processing. Since such a great variety of materials is encountered in the manufacture of grease, it is absolutely necessary that the man in charge of the grease plant have a far-reaching experience, combined with scientific knowledge and training to enable him to determine just what kind of a raw material to use for a particular type of grease. He should know the action of different raw materials with respect to the finished product; he should know what to add and what to omit in order to make these same products meet specified requirements. To a certain extent, some of this knowledge may be obtained from text books, but for the most part it is necessary that he be guided by his past personal experience based, primarily, upon keen observation, and this, in turn, enables him to successfully solve the various problems which arise almost daily.

To proceed to the discussion, let us first consider the classification of raw materials and equipment comprised under the heading

Soap Stocks

Soaps, contained in lubricating greases, may be prepared from any kind of animal or vegetable oil or their respective fatty acids, which are capable of being saponified by an alkali. In the selection of saponifiable oils to be used in the production of grease we naturally find the price of same to be of prime importance and consideration. If, however, quality products are desired, in that we must give no little thought to the color of the finished product, the odor, texture and melting point, then the price alone cannot be too potent a factor in the selection. The type of processing equipment available also has a tendency to either enhance or modify our choice of a fat. Occasionally, in the preparation of some greases it is of advantage to use a combination of fats or fatty acids in order to obtain definite and desirable characteristics in the finished commodity. As an example, suppose we wished to replace horse fat in order to gain certain qualities, but still retain the smooth texture and unctuous consistency provided by the use of horse fat. In this case a mixture of tallow and lard oil may be used with excellent results.

Some greasemakers prefer to use fatty acids rather than the whole fats or glycerides. With the exception of a shorter time being required to complete saponification and the use of a little less soap stock, there is really hardly any difference, even to the appearance of the finished grease. With regard to quality, however, some greasemakers are of the opinion that lubricating greases made from fatty acids are not as stable as lubricants made from whole fats, as in time and under pressure they seem to have a tendency to separate, liberating the lubricating oil contained therein. But these are more or less personal opinions.

Fats of the liquid fatty acid type, such as fish oils, etc., produce lubricating greases of lower melting point and more or less rubbery texture, while soap stocks of the solid fatty acid type, such as tallow, etc., are important in the manufacture of hard and high melting point lubricants.

Not only the careful and intelligent selection, but also the efficient handling of the soap stock appears as an important factor in the manufacture, as the quality and character of the finished product is somewhat dependent upon this phase of the processing.

Usually the soap stock storage tanks are located either outside of the grease plant or in the basement cellar of the same. Therefore, it is necessary to convey the fats from these storage tanks to the kettle floor. This is done very effectively, either by pumping with steam or electric pump, or by blowing with air. Liquid fats, provided they have a sufficiently low titre, can be handled in this way without any trouble, but where solid, or semi-solid soap stocks are encountered, the storage tanks must be provided with some kind of a heating device, usually steam coils, either internal or external, in order to keep the fats constantly in such a state as will permit them to be readily pumped or blown to the measuring tanks and thence to the soap kettles.

Due precaution should be exercised to keep the temperature of the soap stock just a little above the melting point of the same, as excessive heat has a tendency to darken the fat and accelerate oxidation and rancidity, which, in turn, give the finished product an objectionable color and odor. Several chemical compounds which have appeared on the market recently are intended to suppress the oxidation of soap stocks when added in very small quantities. In the writer's opinion, however, proper handling of the fats, combined with absolute cleanliness of the storage tanks and equipment, make the use of these so-called "oxidation inhibitors" unnecessary.

In smaller grease plants, where soap stocks are purchased in barrels instead of tank cars, the efficient handling of the fats is much simplified since greater care can be conveniently exercised, owing to the smaller amounts of fat handled.

Hydrated Lime

The hydrated lime used in the manufacture of lubricating grease should be of the highest quality and purity and should always run uniform as to its available calcium oxide content. The amounts of contained magnesia and silica should be as low as possible, as otherwise serious trouble may be encountered in the quality of the finished grease.

A lime suitable for the manufacture of lubricating grease, and one which has been consistently used with gratifying results is characterized by the following composition:

Calcium Oxide	approx.	74.25%
Iron Oxide and Alumina	"	.25%
Magnesia	"	.75%
Silica	"	.25%
Water (combined)	"	24.00%

The lime should be of sufficient fineness that 100 per cent of it will pass 200 mesh and also a chemical analysis of each shipment of lime should be made to definitely inform one's self of the actual available calcium oxide content of that shipment.

It will be found that lime may be conveniently and easily handled, even by one man, if purchased in 50-pound paper

bags. This size also facilitates the packing of the lime in storage. It should be stored in a dry place to eliminate the absorption of moisture and to prevent the neutralization of the calcium hydroxide by the carbon dioxide of the air.

Caustic Soda

Aside from lime, caustic soda is the alkali which is used to a great extent in the manufacture of lubricating greases. All fibre greases, a number of transmission lubricants and many other lubricating compositions contain soda soap as thickening agent. Therefore, some consideration should be given to the specification and handling of such an important raw material as caustic soda.

Caustic soda may be purchased in two forms, either as a solid, fused material, or as a 50 Baume solution. Where sufficient storage space is available it is better to handle a 50 Baume solution as it saves the greasemaker the dangerous and time-consuming job of breaking up the solid material and dissolving it.

With regard to chemical composition, the caustic soda should be as free as possible from iron and alumina and sodium carbonate. As caustic soda is very seldom used stronger than a 30 Baume solution, it is advisable to have a mixing tank in order to make up and adjust the caustic soda solution to such a concentration as is required for the particular process.

The concentrated caustic soda solution (50 Baume) is usually stored in a tank from which it may be pumped or blown to either one of two kinds of mixing and measuring tanks. A stationary tank may be used, the discharge lines of which run directly to the kettles where the caustic soda is to be used. The amounts of soda of the proper concentration used from this tank, are usually measured volumetrically.

A movable tank, consisting of a regular 110-gallon oil drum mounted on an ordinary factory truck, may also be used. This enables the operator to move same to the scale and weigh it. It can next be moved to the desired kettle, the soda solution run in and then reweighed. The latter gravimetric method favors accuracy.

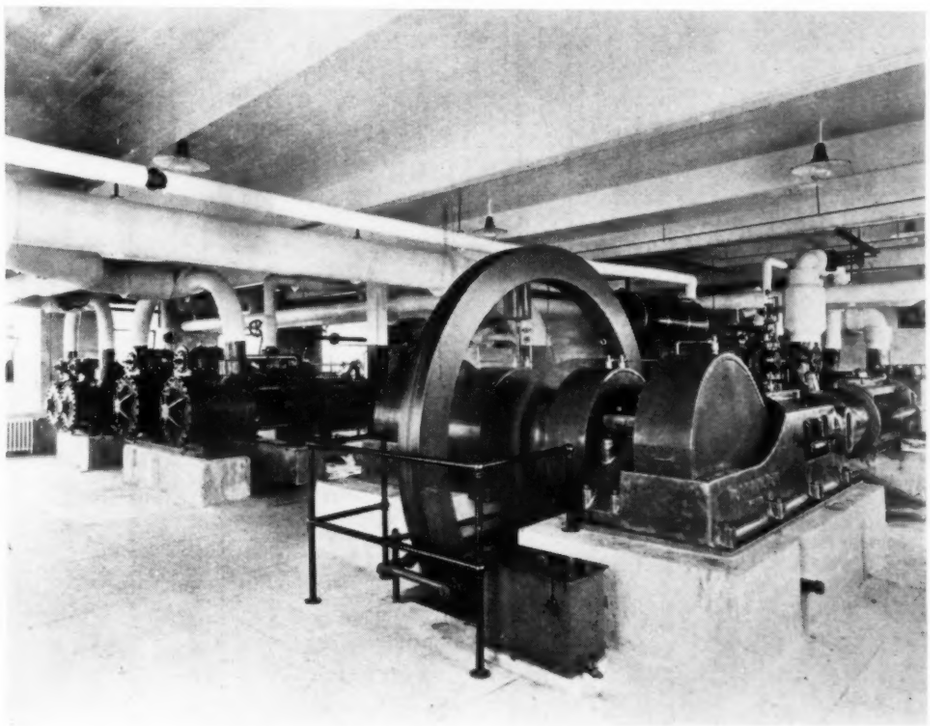
Mineral Oil

Since the lubricating value of a grease is more or less proportional to the lubricating properties of the mineral oil contained therein and since this same mineral oil imparts many of its properties to the grease, then it is important that the proper selection and handling of the lubricating oil be carefully governed.

A large variety of oils, ranging in price and quality, are constantly being offered to the greasemaker. Consequently it requires considerable experience to select the oil best suited to the purpose. Fortunately the consumer of these oils is aided by the fact that this selection becomes limited, dependent upon the use to which the particular grease is to be subjected. To cite: A low viscosity, low flash oil is not suitable to be used in the manufacture of a high melting point grease. Naphthenic base oils are usually preferred to neutral paraffin base oils, as they seem to be better able to form a gel and higher percentages of oil may be incorporated without impairing the consistency. In short, the viscosity of an oil and its history, with respect to its source and method of refinement, govern the selection for the most part. The equipment ordinarily used in the handling of lube oils is the same as that discussed under "soap stocks".

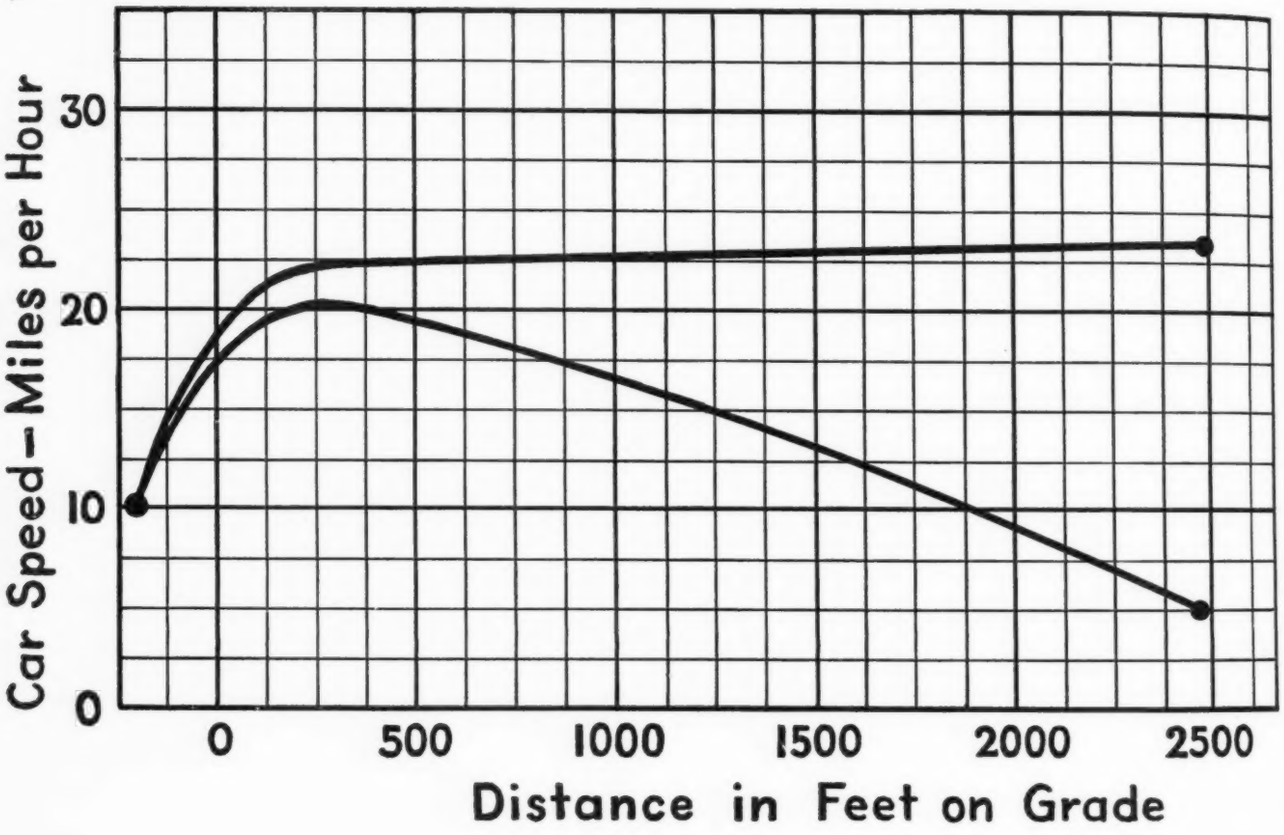
Other Materials

Other materials such as graphite, soapstone, asbestos, paper pulp, talc, clay, bentonite, etc., are also used, sometimes as fillers. A general discussion of these individual materials cannot be attempted as their uses are, in reality, too variable. Their use is governed by the nature and character of the grease desired and may be considered as special cases.



Hot Oil Pumps, British American Oil Company, Montreal, Canada, Refinery.

HIGH



12% GRADE REVEALS STRIKING DIFFERENCE IN PERFORMANCE. Two cars of identical size, weight, and engine equipment *except* for cylinder heads approached the test hill in high gear, running side by side at ten miles per hour. At a given point just before reaching the grade both accelerated to the full power of the engine. The graph above tells the story of car speeds after that point. The car with the higher compression head (5.6 to 1) reached a speed of twenty-two and a half miles per hour soon after starting up the climb. Thereafter it maintained that speed (with slight acceleration) until the top of the hill was reached. The car with the lower compression head (4.8 to 1) reached a speed of twenty miles an hour BUT then lost speed steadily until at the top of the hill it was moving a bare five miles per hour.

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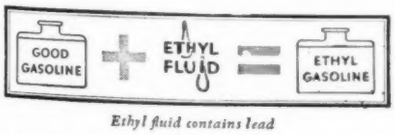
AUTOMOBILE sales during the past two years have emphasized the importance of performance. Better performance sells cars. Better performance in new cars is putting older models out of date.

The outstanding sales lesson of the past three years in both the automobile and the gasoline industry is this: *The American public is willing to pay for performance.*

A staff writer of the Oil and Gas Journal quoted the president of a leading automobile manufacturing company as estimating "that 2,000,000 automobiles will be bought in 1932—and that the feature of the 1932 automobile engine will be a higher compression ratio. Refiners looking beyond 1932, 'when times will surely be better,' may give thought to the recently released figures which show that about 13,000,000 of the automobiles now in operation are at least five years old."

The fact is that nearly every major car manufacturer in the country is now offering either a standard high compression line or optional high compression heads. The competitive superiority of these cars is going to make old cars and *some new cars* look pretty bad on the basis of comparative performance—unanswerable argument on the road.



Ethyl fluid contains lead

The hill-climbing test illustrated above is a fair example. It reveals the relative merits of the standard low compression head and the optional high compression head now being sold by a manufacturer of light weight cars. With the 4.8 to 1 head this car loses speed quickly on a 12% grade and is forced to shift gears. With a 5.6 to 1 head the same car maintains its speed and gains slightly. That all increases in compression produce corresponding improvements has been demonstrated repeatedly in cars of every price class.

The day of high compression is here—true—but high noon of that day is still distant enough to present competitive opportunity to those manufacturers who take greater advantage of high compression now. Proper fuel is already universally distributed and regularly used by a large share of the potential customers for *your* new model.

The survey recently completed by the U. S. Bureau of Mines shows that the average anti-knock rating of premium priced fuels has increased appreciably since a similar survey one year ago.

On March 1, 1932, the minimum anti-knock standard of Ethyl Gasoline was raised to a new level. The new Ethyl Gasoline has sufficient anti-knock quality to develop the maximum performance of engines of considerably higher compression ratio than even the high average of 1932 models.

New Standard for Ethyl Gasoline Announced

As you read this, gasoline pumps throughout North America bearing the Ethyl emblem are being filled with Ethyl Gasoline of an even higher standard of quality.

The anti-knock standard of Ethyl has been raised to meet the peak requirements of the super-high compression motors the automobile industry is now sellir.g. It brings out the *full* performance of the highest compression engines on the market today.

Short Tube Condensers *in* Refinery *and* Natural Gasoline Plant Service

L. J. COULTHURST* and L. P. SCOVILLE*

Corrosion Problems

THE correct design and operation of condensers is now recognized as being of major importance. Efficient condenser design is combating the inroads of corrosion by reducing the amount of surface subjected to corrosive action. The problem of condenser corrosion has increased due to the installation of larger units and to the processing of high sulphur crudes.

Corrosion and erosion often work together. Erosive substances scour the surface clean and facilitate chemical reactions by washing away the products of corrosion. The deposit of scale may not necessarily be a direct cause of a reaction but may lead to it. Admiralty metal tubes in particular should be kept clean, for a break in a scale film tends towards localized corrosion. These corrosive areas usually form characteristic pits with a shallow tail downstream and a deep section upstream.

Dezincification

There are several forms of dezincification in alloy tubes which are designated by some engineers as plug and surface types respectively. In the plug type white particles of a tightly adhering zinc oxychloride form on the surface. When these are removed there usually appears an area of spongy copper tinged with a green copper salt. In the surface type of dezincification the zinc is removed leaving a spongy brittle copper behind. Occasionally this red brick colored copper extends entirely through the tube wall. The presence of mineral acids or acid forming salts brings about this change.

A third form of dezincification which is occasionally encountered, is caused by means of an external electromotive force. It is the result of an attack of the metal as a whole wherein the copper is set free more rapidly than it can be oxidized. This reaction is favored by high temperatures and by a high zinc content of the tubes. The tendency to dezincification decreases in brasses as the copper content increases, therefore, the obvious solution would be to use high copper content brasses. However, the solution to the difficulties of dezincification is not so easily solved, for this characteristic is offset by the fact that alloys of this type have a tendency to pitting and general corrosion.

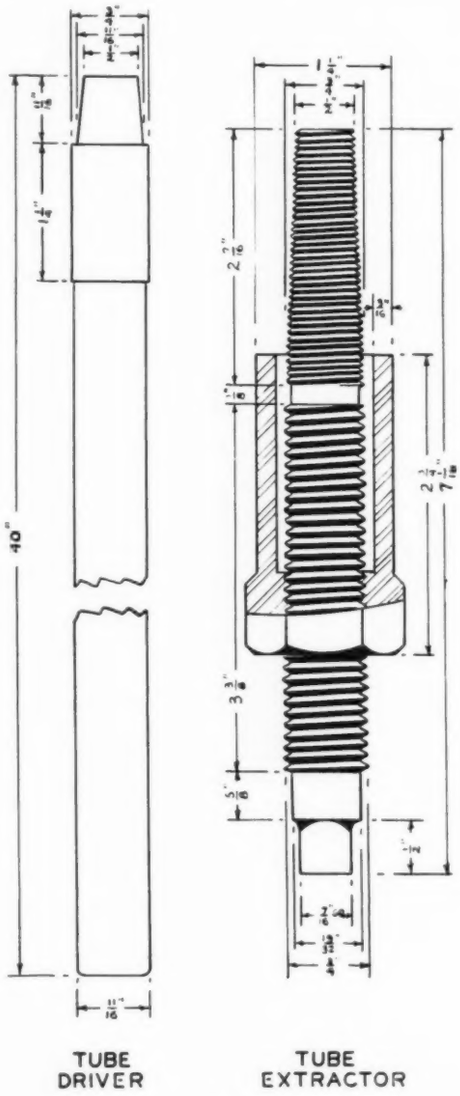


Fig. 1.

Corrosive Agents

In refineries that have a cooling tower, it becomes feasible to treat and filter the make-up water, thus allowing the use of a relatively noncorrosive, nonscale-forming circulating water. The use of cooling towers results in the water containing a large percentage of dissolved oxygen. Oxygen prevents equilibrium being established and consequently is an important corrosive agent. The use of ordinary deaerators have not been economical, with the result that it is necessary to design condensers to prevent oxygen segregation.

Salt water may be used satisfactorily in condensers if operation, conditions, and materials of construction are correct. For example, salt water is very destructive to iron. The green chloride of iron is first formed, which upon oxidation turns to rust. Hydrochloric acid, thus liberated, attacks more iron and so on continually.

A majority of corrosion is found on the vapor side of condensers. The principal corrosive agents are hydrochloric acid and sulphuric acid, sulphur and sulphur compounds.

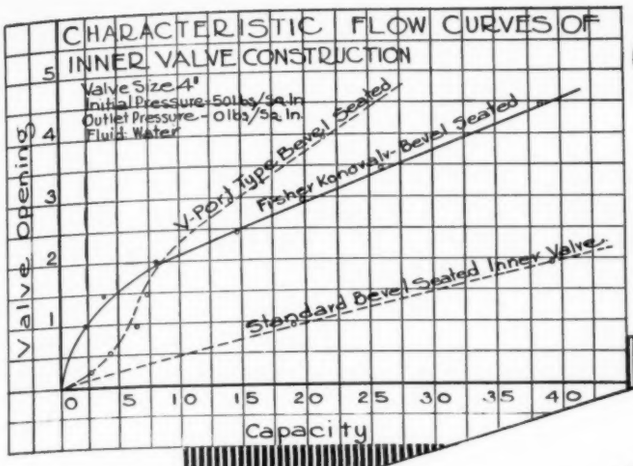
Sodium and calcium chlorides are not necessarily serious corrosive agents, but cause trouble in the form of scale on hot tube surfaces. Most hard scales are caused by the presence of calcium sulphate, whose solubility in water decreases as the temperature rises above 90 degrees F. Magnesium chloride is a producer of hydrochloric acid. Sulphur may be in two forms: the organic and the inorganic. The inorganic form is represented by hydrogen sulphide which has a tendency to attack steel tubes forming iron sulphide and elementary sulphur. In the presence of oxygen there is the possibility of hydrogen sulphide forming sulphuric acid.

Combating Corrosion

The circulation of an excessively weak caustic solution has been successful in minimizing hydrogen sulphide corrosion. The necessity for circulation of an excessively weak caustic solution is to prevent the formation of quantities of sodium acid sulphide and to reduce the tendency toward caustic embrittlement.

The use of ammonia or one of the alkalis has proven successful in combating hydrochloric acid corrosion. The injection of ammonia in the condenser vapor inlet will

*Chemical Engineers, South Pasadena, California.



The REPORT on KONOVALV

FISHER GOVERNOR COMPANY
Inter-Office Correspondence

FORM 148

Date March 16, 1932

Mailed From

Subject Report on Konovalv

To Mr. J. H. Fisher, Pres.

Dear Mr. Fisher:

I am pleased to advise that the complete design and capacity work has been completed on our new inner valve, the Konovalv, which gives us, in actual test, the ideal flow curve.

You will recall the engineering department gave us a flow curve and stated that all sizes of Konovalvs must produce that curve in test. This has involved eighteen months of intensive work because each size valve had to be individually designed. A common curvature for the Kono part of the valve in different sizes did not result in the ideal flow curve for all sizes, consequently each size valve has a different curvature.

The factory has a new line of reversible bodies in which to use the Konovalv and we are now in a position to give our customers the most modern throttling flow valve in a superior reversible valve body.

Very truly yours,

FISHER GOVERNOR COMPANY.

Chief of Research Department.

ASK FOR BULLETIN 830

Fisher Governor Company

201 SOUTH FIRST AVENUE
MARSHALLTOWN, IOWA

FISHER TRADE MARK

1015 SANTA FE AVENUE
LOS ANGELES, CALIF.

cause ammonium salts to precipitate. Therefore, it is essential to provide facilities for easily removing the deposits.

In order that the general plant equipment is not exposed to the total of the corrosive substances present, many cases of treating the crude oil with hydrated lime have proven successful. Care should be taken that this method does not raise the ash-content of the fuel oil to too high a value.

Condenser construction material varies according to the service demanded of it. In processing high sulphur crude oils chrome nickel alloys have been used to good advantage. However, these alloys are subject to hydrochloric acid corrosion.

It is sometimes necessary to use steel shells with Admiralty metal tubes and Muntz metal tube sheets because of the necessity for strength. The usual result is a severe corrosion of the shell. In spite of its susceptibility to dezincification the most widely used Admiralty metal tube is 70 per cent copper, 29 per cent zinc, and about 1 per cent tin. Admiralty metal may be considered as a standard for condenser tubes when using sea water and is very popular for fresh water service.

Services in which strength is not a factor have been successfully coped with by the use of a nickel cast iron shell, nickel cast iron tube sheet and Admiralty metal tubes. This combination of metals will allow the use of natural, brackish, or salt water for a cooling system.

Various claims have been made for the successful use of metal and other types of protective coatings for tubes, tube sheets, and shells.

Methods of Scale Removal

After carefully considering the design and material for condensers it is imperative that they be kept in good operating condition. A brief description of a method of cleaning short tube condensers and the tools employed will indicate the simplicity of their care.

Access to the tubes of a short-tube type condenser is facilitated by hinged cover plates. It is necessary only to remove the bolts from the two heads and to swing the cover plates on their hinges to obtain a clear view of the tubes.

If inspection of the tubes reveals some of them to be tightly plugged they should be removed from the tube sheet by a method to be described later. If a hard scale is deposited it is necessary to use an ordinary twist drill similar to a ship auger bit. These drills are of varying sizes depending upon the thickness of the scale film. The drill is rotated by means of a one-half horsepower motor and is inserted into one end of the tube opening. It will be found advantageous to force the water for cooling the drill into the opposite end of the tube. This is at variance with the method for long-tube cleaning in which the water enters the tube at the same end as the drill. After cleaning with the drill a final polish is obtained by use of a wire brush.

If the accumulation in the tubes is an emulsion or a soft deposit, the wire brush will perform the necessary cleaning.

Scale removal has been successful by the use of a sand blast. Excellent results have been obtained with this method but it is tedious, disagreeable, and dangerous, especially in natural gasoline plants.

Occasionally it is necessary to dissolve scale by use of a weak hydrochloric acid solution. If the circulating water contains a large percentage of chlorides this method is not recommended. A slight scale film would tend to protect the tube, whereas a perfectly clean tube would subject the metal to a more intense corrosive action. For a one-hour treatment the circulation of a 2.5 per cent solution by volume will be found to be satisfactory. Regardless of the method used to circulate the acid a vent should be provided to allow the escape of gases generated by the chemical reactions.

A method for cleaning condensers on the shell and occasionally on the tube side is to circulate a hot solution of a cleaning compound with a trisodiumphosphate base.

The simple group of necessary equipment is as follows:

An open top 350-gallon tank,

A small reciprocating pump such as 3½x2¼x4, and

Two flexible rubber fabric hose with suitable pipe fittings.

The circulating fluid is a mixture of approximately 100 pounds of the chemical to about 250 gallons of water. The hot temperature of the solution is maintained by means of open steam in the tank. An inspection of the fluid after passing through the condenser will indicate the cleanliness possible to be obtained. By this method of recirculation six condensers have been cleaned collectively in three hours time.

Tube Replacement

It has been found to be more economical to remove a tightly plugged tube and replace it with a new one than to spend the time in labor necessary to drill it out. Thus, it is necessary to have only a few spare tubes for replacement purposes rather than have a complete tube bundle.

The tools necessary in tube removing are the driver and the extractor (figure 1). The driver is merely a case-hardened steel rod with a shoulder. The material from which the extractor is made should adhere to fairly definite specifications. The following are specifications which have given satisfaction over a period of years:

Nickel chromium steel
30-40 points carbon
.45-.75% manganese
.04% phosphorus
.045% sulphur
2.75-3.25% nickel
0.60-0.95% chromium

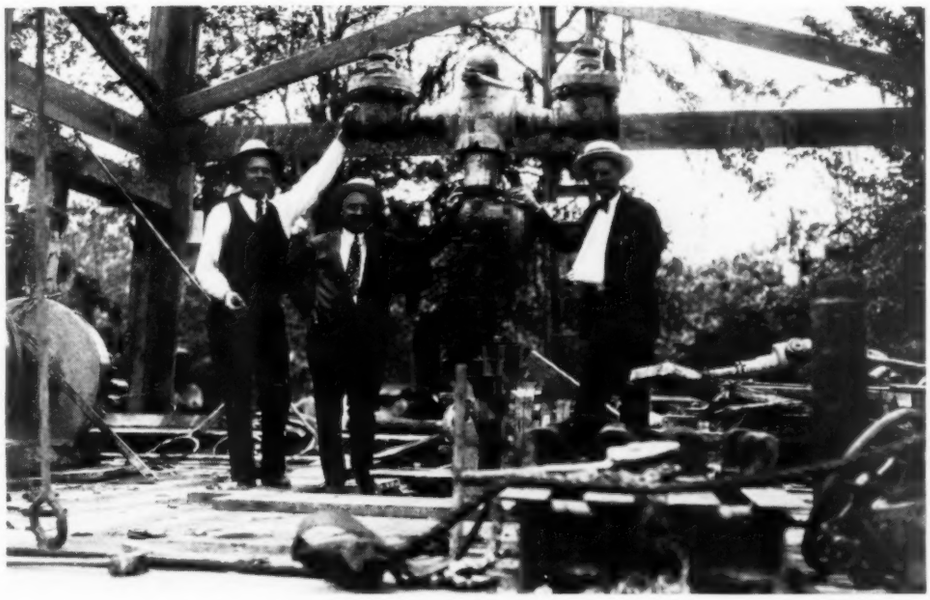
Preheat to a dark red color and then gradually to 1400-1475 degrees F. Quench in a good grade of oil and draw to at least 375 degrees F. and for extreme toughness to 450 degrees F.

The removal of short tubes may be accomplished by one man but it is more economical and satisfactory to use two for the job. One man inserts the tapered thread of the extractor in one end of the tube and by tapping it and turning a wrench placed on the square shank, is able to obtain a substantial hold inside the tube. The lock nut is turned tightly against the tube sheet. The other man places the driver inside the opposite end of the tube and begins to force the tube through the tube sheet by means of blows from a sledge hammer, or preferably an air gun. The lock nut on the extractor must be kept snugly against the tube sheet at all times so that a tension is maintained in the tube. When the end of the tube on the driver side of the condenser has passed the tube wall the extractor may be removed. The final removing of the tube is accomplished by the driver alone.

The rolling of new tubes into the tube sheet should be carefully performed. An overworking of tubes will distort their entrance and cause split tubes during the flaring operation.

JACKSON, MISSISSIPPI EASY DRILLING AREA

By FRANK H. LOVE



Love Petroleum Company's Mendoza No. 1, first commercial well in Jackson field. Reading, left to right: L. P. Love, J. A. Roell and J. W. Love.

WITH the Jackson, Mississippi, gas field having recently passed its second producing anniversary (the discovery well was brought in February 16, 1930), a review of operations in the area reveals that the principal characteristic as pertains to drilling is the facility with which the wells have been put down.

The producing formation is penetrated at a comparatively shallow depth, the average being from 2,350 to 2,500 feet, and the upper horizons, with few exceptions, are made up of formations that offer but little drilling resistance. The principal exception is encountered in the Wilcox formation and consists of boulders varying in thickness from two to eight feet, but these have never presented any serious difficulty, although, naturally, drilling becomes proportionately harder and slower and weight on the drill pipe string must be watched to prevent off vertical direction of the hole.

In virtually all instances the first 1,150 feet offers easy drilling. Then (for approximately 1,200 feet), Wilcox formation is encountered with its sand and shale and the forementioned rock formations. Black shale comprises the strata for about one hundred feet below the Wilcox and is usually fairly hard to drill. This horizon also contains a few boulders. The cap rock, as a rule, is hard and offers considerable resistance for a few feet; but the pay formation, of a chalky lime, is extremely soft and crumbly. This usually results in serious mud loss. The formation is penetrated only to a depth of two to four feet in most instances, and is seldom cored, because of its porous nature.

The top of the Wilcox is cored by one major company, and the top of the Midway is usually cored except in absolutely proven territory. While for some time the age of the pay formation was in question, it is now generally conceded that it belongs to the Selma age, and that the cap rock is a thin remnant of the Midway period.

The ease with which drilling is possible in the Jackson area is indicated in the speed with which wells are completed and their comparatively low average cost. From the erection of the rig until the well is brought in, the average drilling time is from two to three weeks. Drilling contractors' prices range from $10,000 to $10,500 for turnkey jobs.

Rotary drilling equipment is used exclusively in the Jackson field, the average derrick is 112 feet high (some few are 96 feet), and of both wood and steel construction. Drilling engines are for the most part of the 12 x 12 single-cylinder type. A small number of 11 x 11 twin-cylinder engines have been used. Because of the ease with which drilling is possible but one 60-horsepower boiler is needed at each rig and only one slush pump of 12 x 6 x 12 size. Mud weighing nine pounds to the gallon is used for ordinary drilling, although for drilling in, operators use a mud weighing eleven pounds to the gallon. The crown block ordinarily used is of single-deck type with four lines used for drilling and seven for setting casing. The rotary table is usually 40-inch, sometimes 42-inch. Three-speed drawworks, with four-inch line shaft, are commonly used. Four and a half

inch drill pipe, weighing 19 to 22 pounds per foot, has been found best suited to the conditions. At times the wells are drilled in with three-inch pipe.

Fishtail and six-way bits are the predominant types employed, with rock bits put into service to remove the boulder obstructions encountered in the Wilcox. The rock bits seldom are used for more than a few feet of drilling at a time.

Water for rig operations is easily obtainable. A large portion of the field is within the city limits of Jackson and operators are permitted to avail themselves of the municipal water system for their requirements. An additional source of supply is the Pearl River, and in those parts of the field where it is necessary to drill water wells, the required depth is only about 25 feet.

The casing program employed by the major companies calls for the setting of 40 to 80 feet of 16-inch pipe cemented to the surface with 25 to 75 sacks of cement. The next string runs in length from 700 to 800 feet and this casing is 10-inch diameter; 75 to 150 sacks being necessary for cementing purposes. When the well is within the city limits, as is more often than not the case in the field, an ordinance sets a 750-foot water string as the minimum in length. The flow string is of 6⅝- and 7-inch pipe and 100 to 200 sacks of cement are used to set it, depending upon the depth of the hole. This string is usually set on top of the gas rock, or in the black shale a short distance above the top.

Many of the smaller operators use a casing program calling for 75 to 300 feet of 10-inch pipe, and a flow string of 6⅝- or 7-inch pipe, except within the city, of course, where the city regulation must be observed.

The surface elevation of the field is but 260 to 355 feet above sea level, and while not low enough to be swampy, presents a number of problems during the rainy season of the year, and this has been noticeable within the past few months. Several rigs, set up and ready to start drilling, have been idle because of high waters. Many operators have stacked their equipment, awaiting more favorable conditions.

Drilling has not been forced in the field and in the two years since the discovery well was brought in only 74 wells have been completed. The combined open flow of these is a little less than 2,500,000,000 cubic feet of gas daily. The flow of individual wells varies widely, the range being as low as 5,000,000 cubic feet daily to as high as 53,000,000 cubic feet. Initial rock pressure of the wells is 1,050 pounds.

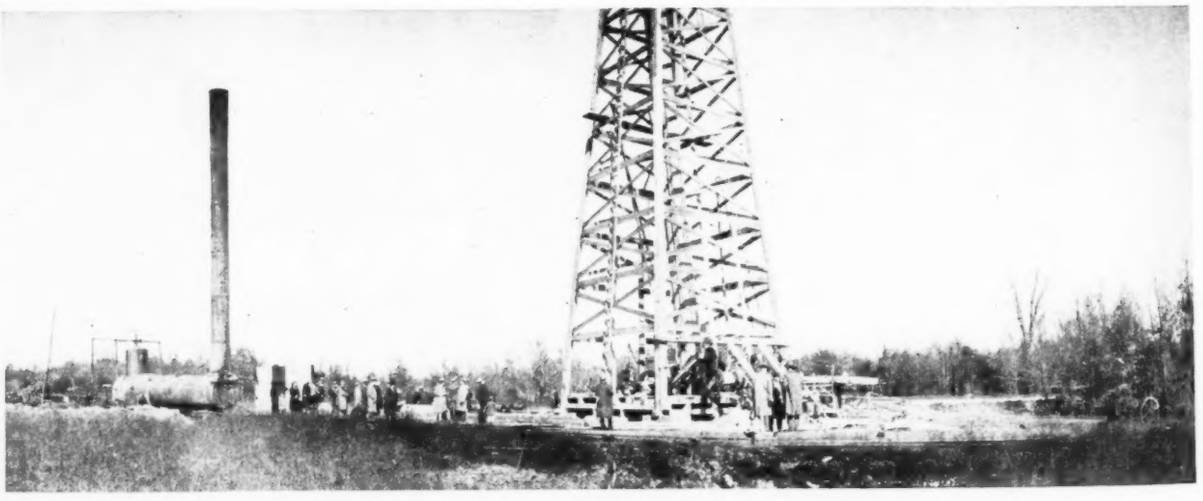
The gas is sweet, contains no sulphur, and has a B. T. U. rating of 950; is quite dry and therefore unsuitable for gasoline manufacture, the entire production being consumed as natural gas. The city of Jackson obtains its entire gas supply from the field and two pipe lines carry the surplus to other points. The United Gas Public Service Company has a line terminating at Pensacola, Fla., and the Mississippi Public Service Corporation has completed a line to Hattiesburg, Miss.

The extent of the field is not extremely large in area, being about five miles from its northwest to southeast extremities and approximately four and a half miles from southwest to northeast. In other words, there are eight to ten square miles of proven area and approximately four square miles of producing area.

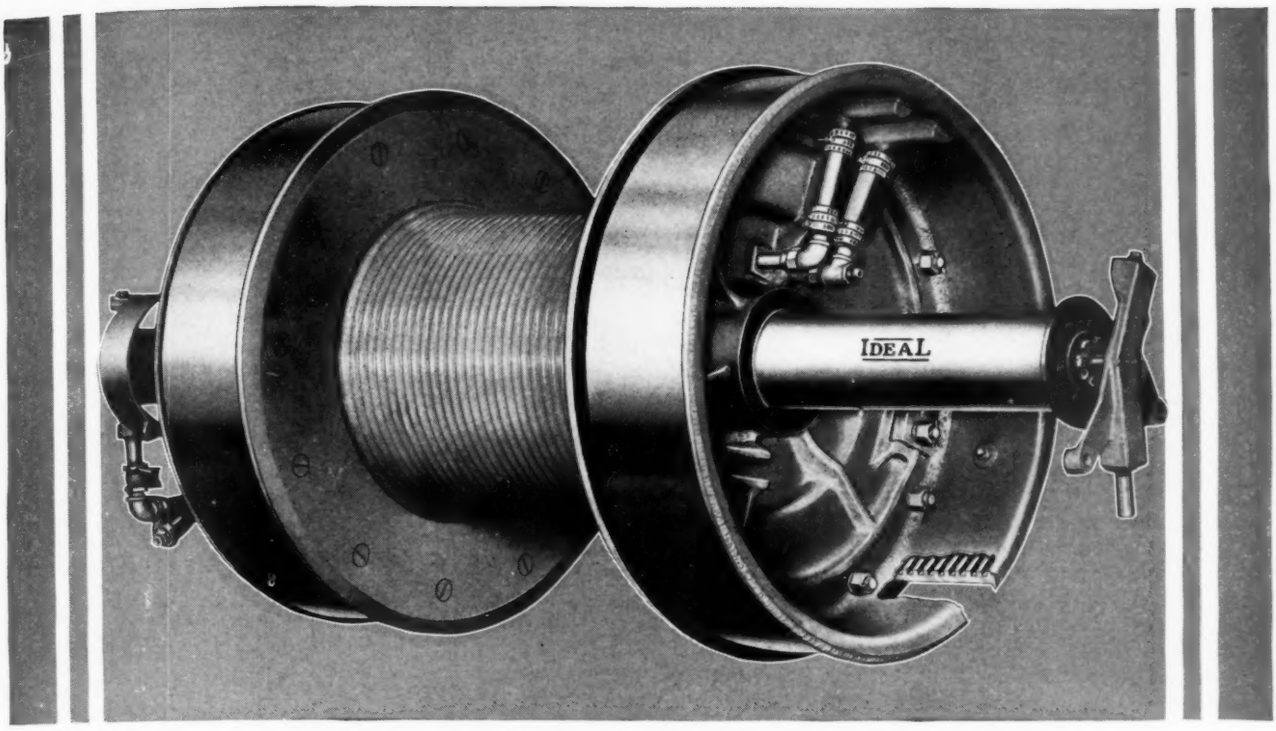
Although E. W. Hilgard, state geologist in the 60s, called attention, in his annual report, to the Jackson structure as long ago as 1860, first actual drilling in the area was not started until 1917. This operation was commenced by the Atlas Oil Company, March 8, of that year and resulted in a dry hole, abandoned at 3,079 feet on June 7. That same year the Arkansas Natural Gas Company drilled a hole to the depth of 3,043 feet before abandoning it.

Several years elapsed before any further operations were attempted; then on March 23, 1925, Mrs. Ella Rawls Reader, et al, began drilling in Hinds County. This operation ended with a hopeless fishing job with part of the drill pipe shot off in the hole. Before drilling was abandoned, however, several oil and gas showings were reported, and those acquainted with conditions believe this should have opened the Jackson field, a belief later given added credence when the Gulf Refining Company brought in its Crane-Lawrence well less than a quarter of a mile westward, producing 10,000,000 cubic feet daily.

The discovery well of the field was the Jackson Oil & Gas Company's Mayes No. 1 which blew in February 16, 1930, making 2,000,000 to 6,000,000 cubic feet of gas per day. It was drilled too deep, however, and into salt water, necessitating a workover job to make it a commercial producer. This operation was completed October 27, 1930.



Discovery well in the Jackson field, Jackson Oil & Gas Company Mayes No. 1 (Feb. 16, 1930)



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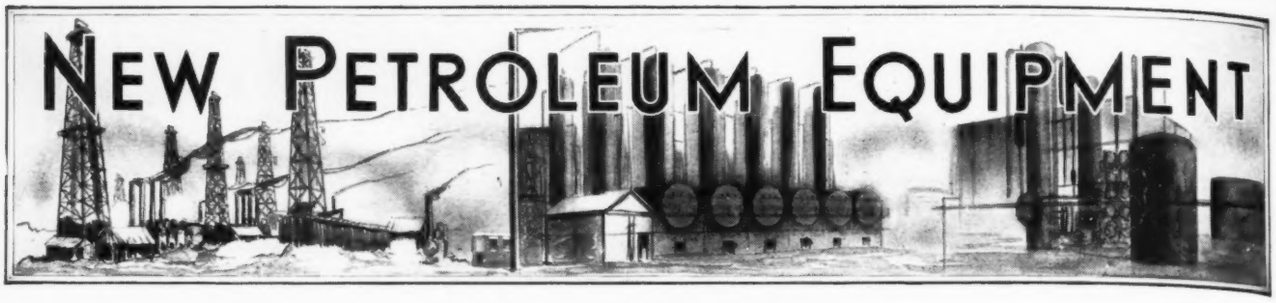


East Texas Underpull Pumping Jack

A NEW product of W. C. Norris, manufacturer, Tulsa, Oklahoma, is the East Texas Underpull Pumping Jack, designed for pumping 4,000-foot wells through 2½-inch tubing. It is of welded construction, with machined bearings, steel shafts, improved lift and long stroke.

The structural steel frame is made of six-inch channels, and is self-contained, self-supporting, with welded beam, all arc-welded. The beam is made of eight-inch by 15-foot channels trussed with six-inch channels.

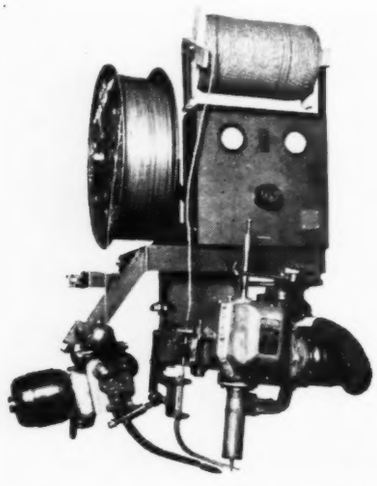
The machined bearings with oil grooves, carry oil the full length of bearings from large oil reservoirs, which holds the oil in and keeps out rain and dust. The steel shafting is of large diameter in the saddle and with the pull-bar bearing result in a strong vibrationless action.

The straight lift of the polished rod is accomplished by the W. C. Norris underpull jacks through a unique combination of arc and link design. The lift is adjustable up to 48 inches, by moving the pull-bar bearing up or down on the plate. However, it is possible to obtain a 60-inch stroke with this jack. The jack is equipped with rubber bumpers, which cushion the links against projections on the arc, thus freeing the polished rod from contact with the arc at the point of strain. This new method of accomplishing straight lift movement frees the polished rod from bending strains.

Automatic Welding Head

A WIRE feeding head which allows automatic arc welding with the shielded arc process has been developed by The Lincoln Electric Company of Cleveland, Ohio.

The result claimed for this head is very high speed operation on either butt, fillet or building up welding, the deposited metal having physical characteristics of mild steel.



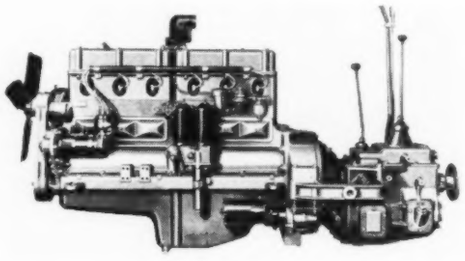
The shielded arc technique is secured through the use of the Electronic Tornado welding head and a fibrous autogenizer which is fed into the arc flame. This autogenizer burns and forms a gas excluding the oxygen and nitrogen of the atmosphere while the metal is molten. The welding head utilizes a carbon arc around which is superimposed a magnetic field which directs the arc stream on the line of fusion.

Full automatic control of the arc is obtained, thus maintaining the heat of the arc constant. Means are also provided for varying speed of the travel of the head through a wide range.

Continuous filler metal is obtained from a reel mounted on the head and fed into the arc just in front of the arc travel. Means are provided for varying the rate at which the filler metal is fed into the arc so that the amount of metal deposited can be varied to meet the conditions demanded by the speed of the head and the type of weld being made.

International Six-Cylinder Motor Trucks

TWO new six-cylinder motor trucks, each with a rated capacity of five tons, have just been announced by International Harvester Company, Chicago, Ill. These are the Model A-7 and Model A-8 and are available in wheelbases of 160, 180, 200 and 225 inches, thus adapting them to a wide variety of heavy hauling.



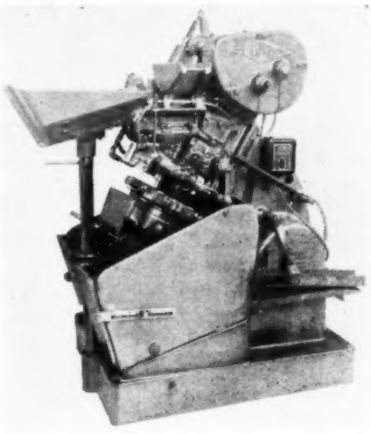
Instead of the usual two springs, there are four springs at the end; these are semi-elliptic springs, one being mounted above and the other below the rear axle on each side. Both upper and lower springs are attached at the front to a swivel-beam equalizer, which equalizes torque and driving stresses.

The rear axles are of the full-floating, double-reduction type with spiral bevel gears in the first reduction and herringbone gears for the second reduction. Both new models are equipped with four-wheel service brakes. The front wheel brakes are of the internal-expanding, self-energizing, shoe type with a vacuum-operated booster. The rear-wheel brakes are of the internal-expanding, wrap-band type.

Engines are of the six-cylinder, valve-in-head type. Bore and stroke of the A-7 are, respectively, 4½ by 5½ inches and of the A-8, 5 inches by 5½ inches. The A-7 develops 107 brake horsepower and the A-8 has 132 brake horsepower at governed speeds of 1,800 r. p. m. for each unit. Removable cylinders, an International feature, contribute greatly to low cost.

Landis Stud Attachment

THE Landis Machine Company, Inc., of Waynesboro, Pa., has developed a stud attachment for its ¾-inch Automatic Forming and Threading Machine which gives it a production rating of 200 to 500 per cent as a stud machine. This high rating is due to the fact that loading (and unloading) pointing and threading operations are performed simultaneously at three separate stations.



Another noteworthy feature of the attachment is its ability to handle sheared blanks. This unusual practice saves material, eliminates expensive cutting-off operations and reduces manufacturing costs.

The attachment consists of a hopper and a magazine. An agitator located at the base of the hopper insures an orderly and uninterrupted flow of the blanks to the magazine. From the magazine the blanks are fed, one at a time, to a slot through which they drop into an auxiliary magazine. The auxiliary magazine is a sectoral chamber which positions the blanks for transfer to the loading station of the turret. For the second operation, the semi-finished studs are stacked in the hopper with their blank ends at the front of the hopper. The front wall of the hopper is hinged and can be dropped to facilitate loading.

The point head takes care of any variations in the lengths of the blanks and insures uniform length studs. It will also point blanks of uniform length with minimum wastage.

The attachment is a self-contained unit which can be applied to machines in service. It is adjustable and will accommodate studs from ¼-inch to ¾-inch in diameter, from 1½-inch to 6 inches in length and 2½-inch maximum thread length.

Badger Measuring Meter

A NEW measuring meter, designed expressly for the petroleum industry, is a product of the Badger Meter Manufacturing Company, Milwaukee, Wis. Through the employment of two engineering principles, this company has developed a product which it is claimed meets fully the accuracy requirements of measuring petroleum products.

The two engineering principles are combined to provide permanent accuracy and to eliminate the need for replacements caused by excessive wear. They are the "dwell principle" and the "principle of equalized pressures."

The first of these provides that the piston "dwell" at each end of the stroke for one-eighth of the cycle. There is no problem of "dead center" shock, thereby reducing wear and the valve action is simplified, crank mechanism eliminated, liquid speed constant and, when once set, the piston stroke is unchanged.

Through employment of the principle of equalized pressures, tightness of pistons is not a requisite for accuracy. Equal pressures are maintained on both sides of the four pistons, which work in pairs. Any leakage around the pistons is carried out through a regulator and returned to the supply line without going through the measuring device.

This new meter is built in ten sizes, ranging from ⅜-inch outlet to 6-inch outlet.

Automatic Combustion Indicator-Recorder

THE C. J. Tagliabue Mfg. Co., of Brooklyn, N. Y., manufacturer of recording and controlling instruments, are now offering a new all-metal automatic flue gas analyzer known as the Tag-Mono Indicator-Recorder. The instrument not only indicates and records the per cent of CO_2, but also gives an accurate record of the per cent of combustibles, such as $CO+H_2$ which may be present in the flue gases. This is conceded to be extremely important in getting the whole story of what is taking place in the furnace.

The company reports that this new Tag development works on the orsat principle, analyzing chemically and indicating and recording electrically and is surprisingly simple in design. The large illuminated dial and pointers can be easily seen at a distance of 30 feet, and in addition the records are made on a 9-inch, 24-hour circular chart with open graduations inviting a precise study of the continuous performance curve. The Tagliabue company has prepared a new catalog No. 1025, which fully describes and illustrates this new indicator-record, and which may be had by addressing the company.

"Crescent Junior" Tape-Rule

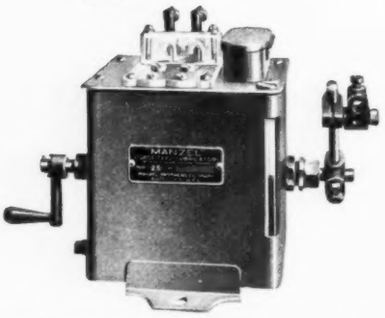
"CRESCENT JUNIOR," a smaller and lighter weight tape-rule, is announced by the Lufkin Rule Co., Saginaw, Michigan. It is a counterpart of the popular "Crescent" and is another most practical combination of the utility of a rule with the accuracy and convenience of a pocket steel tape.

"Crescent Junior" has the flexible and rigid features (both handy in measuring) yet is of neat pocket size, no larger than a watch. It is automatic wind and made in two lengths, 4 and 6-foot.

The blade is ⅝-inch wide and can be projected unsupported to walls or into openings like a rule, and will also accurately measure circles and odd shapes.

Manzel Force Feed Lubricator

MANZEL BROTHERS CO., Buffalo, N. Y., announces a new model force feed lubricator, Model "25". This has been designed primarily with the needs of the oil industry in mind and will operate successfully against the higher steam, gas and air pressures now used in the oil fields.



An important feature of this model is the accessibility of the working parts. While all working parts are completely enclosed in the reservoir, where they are out of dust and dirt and work in oil continually, any unit may be taken from the reservoir at any time by simply removing two screws and without stopping the lubricator or equipment on which installed, or, in the case of multiple feed lubricators, without interfering with any other unit.

In addition, the discharge valves are placed in individual cages and may be removed for repairs, cleaning or replacement with new ones if desired, without even removing the unit from the reservoir.

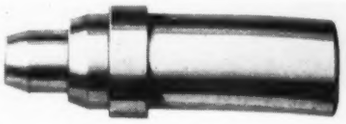
These features permit making of repairs, if necessary, without any loss of production.

Each pumping unit is independently regulated and is capable of very fine adjustment. The ability to feed minute quantities of oil against high gas, steam or air pressures makes these lubricators especially satisfactory on compressors or on gas and air-lift equipment.

A catalog giving complete information regarding this model lubricator will gladly be sent by the manufacturers to anyone interested.

Purox Tip Adaptor

THE Linde Air Products Company, 30 East 42nd St., New York, has recently added to its line of Purox welding apparatus the Purox 11-to-00 tip adaptor, which can be used to increase the range of usefulness of the Purox No. 11 welding torch.

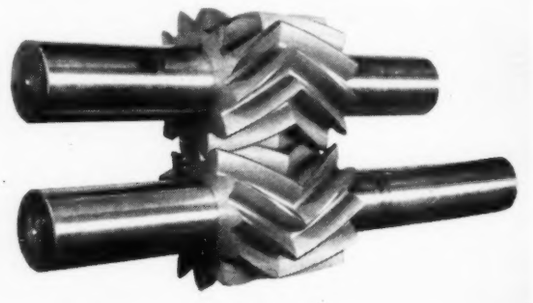


By means of the new tip adaptor it is possible to use the stems and tips of the Purox No. 00-D aircraft welding torch and the stems and tips of the Purox No. 00 welding and lead burning torch on the Purox No. 11 welding torch, thus enabling a welder who has only an occasional light welding job to use the correct welding tips for this small work, and eliminating the expense of a complete lighting welding outfit for merely a few such jobs.

The Purox No. 11 welding torch now becomes the most versatile welding torch of the Purox line of apparatus. It not only takes the Purox No. 21 cutting attachment by which it is converted into a light cutting torch, but, with the new adaptor, it can handle the complete range of general welding work, with the exception only of the unusually heavy jobs.

Farrel-Sykes Herringbone Pinions Used As Pump Rotors

FARREL-SYKES herringbone gears, known for their use as transmission of power, have other applications which are interesting. These gears are used in thousands as impellers, sometimes called cams and rotors, for the gear type pump. They can run at a very high speed, are efficient both mechanically and volumetrically. The smaller size pumps are used with motors direct connected to them, running up to 1800 r. p. m. Such pumps are often used for high pressures; 1,000 pounds per square inch is standard with some makers using Farrel-Sykes gears and in some special cases the gears are used for pressures up to 1,500 pounds per square inch.



Farrel-Sykes pump rotors are made in a variety of material, including bronze, high carbon forged steel, nickel-alloy cast iron, and various alloy steels, including Nitralloy.

These pump rotors are made exceedingly accurate; they have no backlash and no bottom clearance. The shape of the tooth is designed to reduce trapping of the liquid to a minimum and to eliminate hydraulic noises.

For further details on these herringbone pinions as pump rotors write to Farrell-Birmingham Company, Ansonia, Connecticut.

HIGHER TRANSFER TEMPERATURES, LOWER OPERATING COSTS AND GREATER SAFETY CAN BE SECURED BY USING ALCORN FURNACES OR YOUR PRESENT EQUIPMENT REVAMPED BY ALCORN ENGINEERS . . . . . .

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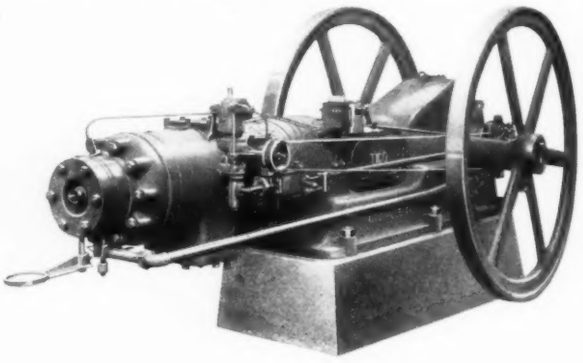
Tico Type B Convertible Oil and Gas Engine

THE latest member of the Tico series engines of the Titusville Iron Works Co., Titusville, Pa., is the enclosed two-cycle convertible oil and gas engine known as Type B Convertible Tico, which has been developed to meet the changing demands of swabbing, drilling and deep well pumping and is specially designed for localities such as East Texas where dual operated engines are likely to be required.

Only two hours is required to change the engine from a gas burner to an oil one and the only auxiliary equipment necessary to make this conversion is an injection pump and injector, cylinder head, special governor, eccentric and rod.

The inlet valve is one of the most important features of the engine, as it determines, to a large extent, the economical operation and continuous performance. The Tico inlet valve is of the poppet type, simple in design, large in capacity, yet strong and light. Its large size admits a maximum of gas and air mixture into the cylinder in a short space of time. The lightness and small lift of the valve allows it to operate very efficiently, without the use of a spring. A positive acting air valve is a part of the inlet valve arrangement, and gives close regulation of air supply and a homogeneous mixture with gas.



Armide Cutters

ARMSTRONG BROS. TOOL CO., Chicago, Ill., announces the development of Armide Cutters, composed of a new carbide and which is recommended for general use.

Armide is a carbide alloy, which the manufacturers state has a keen edge and a high polish. It has a hardness of from 88.5 to 90.5 (Rockwell "no load" C Scale) and a tensile strength of 250,000 pounds per square inch. It is exceedingly hard and wear-resisting and at the same time tough. These features make it able to withstand shock, impact and internal strain. The thermal conductivity of Armide is so low that it remains cool and securely brazed even though chips run hot.

Armide-Tipped Bits (Armide Cutters) of two types and in five ready-ground cutter forms are available at supply houses wherever Armstrong Tool Holders are sold. These Armide bits are designed for general use in Armstrong carbide tool holders and other Armstrong tool holders. They are recommended not only for the machining of unusual substances such as glass, bakelite, synthetic plastics and hard rubber, but for general metal cutting as well.

Multi-Contact Making Pressure Gauges

A MULTI-CONTACT making pressure gauge has been developed by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., for use with supervisory control systems to indicate certain pressure readings at a remote point. It was developed for use with a pipe line pumping station to give remote indications of intake and discharge pressures.

Ten adjustable contacts are placed at predetermined intervals over the scale of the pressure gauge. When the pressure changes sufficiently to make a new contact, a code of impulses is sent over the supervisory control wires to indicate the change to the dispatcher. Thus all changes are automatically sent through without the use of extra live wires.

In general, the device consists of motor-driven contacts which are made to follow the pressure gauge. To accomplish this, the shaft of the pressure gauge is extended through to the rear and a contact mounted on it which will follow the change in pressure. As the pressure tends to change up or down, it strikes another contact which is connected directly to a motor-driven shaft which is connected directly to a motor-driven shaft which rotates it in a direction to cause the contact to again open.

The indicating contacts have a capacity of five amperes at 125 volts. The case is made practically dust-proof and for table or similar mounting. The device is usually made for storage battery operation.

Metallizing Process and Metallizer Gun

A NEW process of metallizing which sprays an everlasting coating of rustproof metal has been developed by the Metallizing Company of Los Angeles, Limited, at 1218 Long Beach Avenue, Los Angeles.

This process has been in use in Europe for many years and is now being pioneered in America by the Metallizing Company of Los Angeles, which has perfected guns and equipment to make it sufficiently portable, practical and economical for use anywhere. This process can be applied to any type of equipment, including wire lines, vessels, gates, etc.

With the new metallizing guns it is possible for one man to rustproof every important metal surface. It is a simple process. The metal, coming in the form of wire, is fed into the metallizing gun which melts it and sprays it like paint, under powerful pressure.

Otis Removable Bottom-Hole Choke

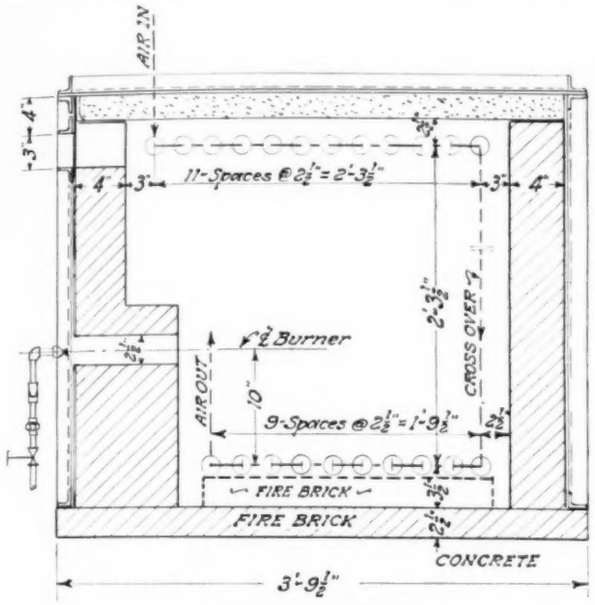
THE Otis removable bottom-hole choke, a product of Southern States Co., Inc., is used to prevent the "loading up", to reduce heading, and to prolong flowing life. The action resulting from bottom-hole choking is that of increasing flow velocity, particularly in the lower portion of the tubing string, by releasing gas held in solution in the oil and by causing this released gas and any accompanying free gas, through expansion, to occupy a greater volume.

The choke is a forged steel product throughout. It is run into the hole on an ordinary round steel measuring line passing through a stuffing box, and is set at any desired depth in any normal string of tubing already in a well. It is pulled by the same method, without pulling the tubing.

Full details of this removable bottom-hole choke may be obtained from the Southern States Co., Inc., Shreveport, La.

A Unique Furnace Installation

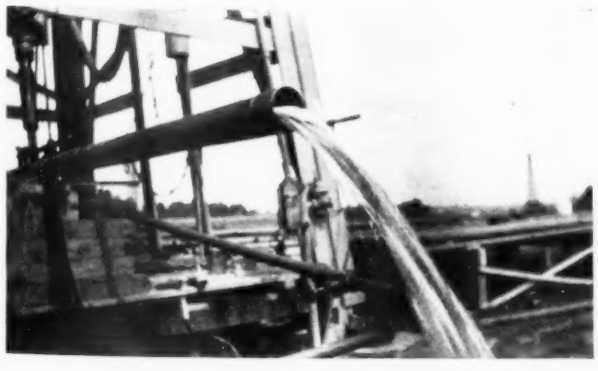
A VERY interesting furnace installation was recently made in the Carbonic Products Co.'s plant in Tulsa, Okla. The service of the unit is to heat air from atmospheric temperatures to 1,000 degrees F. The furnace has 20 cubic feet free space with approximately 90,000 B. t. u. per hour release, and 60,000 B. t. u. per hour absorption. There are 30 square feet of effective heating surface.



CROSS-SECTION

The air to be heated passes through a wrought iron pipe screwed and welded in 180-degree elbows. In service the walls inside the unit show practically no temperature color. There is no actual convection pass, since the unit is vented below the top tubes. However, there is some small convection transfer due to the diffusion of gases.

Emergency Met by Water Flowed from Oil Well



—Photo courtesy of Shell Globe.
The 10,000-barrel emergency water well.

A VERY serious operating difficulty which arose in the East Texas Fields during the latter part of the summer because of the extreme shortage of water presented a puzzling problem to the operators in that district. A scheme that overcame the necessity of drilling a water well was devised by the Shell Petroleum Corporation engineers and as a result many wells which were shut down

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The Fable of
The Rival Truckers

THERE were once two draymen, with one-horse rigs, who served the same community. They met all trains, fought for trunks, and raced each other for the favorite "stands." ¶ They were hustlers, and business grew for each. One of them put on another horse. ¶ To save expense—the other one drove his one horse farther and faster. The foolish one made his deliveries, but he killed his horse.

WAUKESHA ENGINES

Deliver *real horsepower* . . . easily . . . day in and day out. *Write* for Bulletin 827. *Waukesha Motor Co., Waukesha, Wisconsin.*

REAL HORSE POWER NOT PAPER HORSE POWER

3

D. T. Harbison, plant superintendent, testing Nu-Alloy Balls and Seats on Rockwell Hardness Testing Machine.

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. . . . every one you buy has been carefully tested on this machine for hardness . . . . for its degree of resistance to day after day's steady pounding.

When you use Nu-Alloy you can be sure the balls and seats you put into your wells are just right for the particular problem they must overcome . . . . whether it's sand, corrosion, acid, lodestone, or a mean combination of them all!

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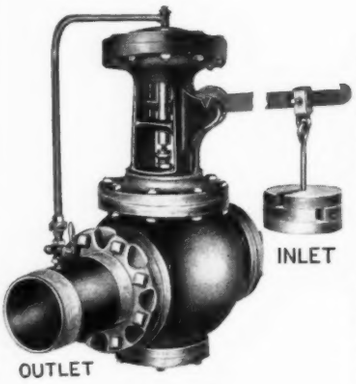
. . for high pressure gas transmission



Two thousand pounds pressure to the square inch can be controlled, and gas can be passed on to the main or the distributing line at reduced pressure to suit requirements, by the use of the proper C-F Regulator. Standard Regulators are designed for pressures up to 600 pounds. For higher pressures, designs are adapted according to specifications.

C-F High-Pressure Regulators are in the reducing stations of practically every gas company supplying natural gas to important cities, east or west. For high or low pressures, C-F apparatus has commanded the confidence of gas engineers from the beginning of the industry. Correspondence is invited. Catalogs are mailed on request.

CF

The Chaplin-Fulton Mfg. Company
28-40 Penn Ave. Pittsburgh, Pa.

because there was no available water for boilers or for mixing mud for drilling, continued in operation.

On the J. B. Watson lease of the Shell Corporation, various water sands were found from 600 to 1,200 feet below the surface. Water wells drilled into these sands have the fluid level standing in most cases at 100 feet under the surface. On this lease well No. 4 had been drilled to 1,435 feet with surface pipe set at 119 feet. When the water shortage became acute, seven joints of 7-inch casing were run into this well, 2½-inch tubing was run inside of this casing. Gas discharged from a nearby well was run into Watson No. 4 as a water lift, and produced 10,000 barrels of water per day.

When the necessity for a water supply from this well no longer exists, the 7-inch casing and 2½-inch tubing will be withdrawn, the sand muddied up again and water shut off and the well drilled to the producing oil sand at 3,600 feet.

R. M. Young Retires as Carter President

When R. M. (Dick) Young retired on April 1st as president of the Carter Oil Co., of Tulsa, Okla., (a subsidiary of the Standard Oil Co. of New Jersey) he concluded a service of almost 40 years under one industrial banner. He began his career in the auditing department of the South Penn Oil Co. and served the interests of the New Jersey corporation in many sections of the United States. During his tenure of office as president of the Carter Oil Co. that concern attained a peak production of over one hundred thousand barrels daily during the Seminole boom. Mr. Young guided the destinies of the "Carter" through a large number of major pools which have been discovered during recent years.

R. M. Young

Shy and retiring by nature, he was the possessor of an exceptional personality, and was held in high regard by those who enjoyed his friendship. He will continue to make his home in Tulsa, Okla. Clarence H. Lieb, formerly of the Standard Oil Co. of Venezuela, has succeeded Mr. Young.

Japanese Buy Equipment for Pipe Factory

A complete set-up of machinery for manufacturing large diameter steel pipe by the Electronic Tornado process of automatic welding in a shielded arc has just been ordered by the Asano Dockyard Company of Japan from The Lincoln Electric Company of Cleveland, Ohio. Installation of this machinery will be supervised by T. Y. Inagaky, Tokyo representative of The Lincoln Electric Company.

This is the second order in the past six months for a pipe factory installation of this kind in Japan.

Statement of the Ownership, Management, Etc., of
THE PETROLEUM ENGINEER
April 1, 1932

(This statement is published in compliance with the Act of August 24, 1912.)

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Known bondholders, mortgagees and other security holders holding 1 per cent or more of the total amount of bonds, mortgages or other securities: None.

W. T. BRYAN, Secretary-Treasurer.

Sworn to and subscribed before me this 1st day of April, 1932.
LILLIAN HADDOCK, Notary Public.
My commission expires December 25, 1934.

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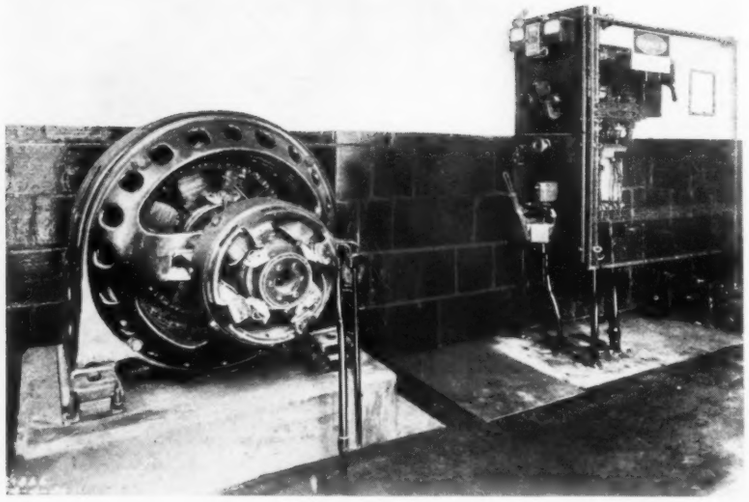


350-H. P., 900 R. P. M. synchronous motor driving hot oil pump in a Texas refinery.

. . . The

SYNCHRONOUS MOTOR IN THE OIL INDUSTRY

» » » » By T. D.

TO PROPERLY select an electric motor, which is the most efficient, commercially, it is essential that the engineer or superintendent be thoroughly familiar with the operating characteristics of the various types of equipment which might be used.

The object of this article is to point out the characteristics of synchronous motors, with their advantages in applications to which they are best suited, and to describe their numerous uses in the oil industry, where they have been in successful operation for a number of years.

The following is a summary of the characteristics peculiar to synchronous motors:

(a) Constant speed at all loads.
(b) Applicable to direct connection to slow-speed machines.
(c) High power factor.
(d) High efficiency.
(e) Simple construction and fully automatic as regards starting and recovering load after momentary interruption of electric power.
(f) Competitive in first cost.

(a) Synchronous motors operate at a constant speed, regardless of the load the machine is driving. In contrast to this characteristic, the speed of induction motors varies directly with the load, as described in a previous article. For example, a synchronous motor designed to operate at 900 revolutions per minute, will run at this speed continuously, while in an induction motor the no-load speed is approximately 900 revolutions, and the full-load speed is 860 revolutions. Constant speed motors have certain advantages, as well as some disadvantages. When driving pumps and production machinery, greater output is the result of constant speed. However, equipment requiring variable speed cannot be driven by synchronous motors.

(b) The characteristics of synchronous motors make possible most economic and satisfactory designs in speeds, ranging from 1800 R. P. M. to 72 R. P. M. Induction motors, however, below 600 R. P. M. suffer a great handicap in performance, because of design limitations. The poor performance of slow-speed induction motors is such that high-speed machines are used, and speed reducers are introduced to obtain the proper speed of the driven machine. The elimination of speed reducing equipment, wherever possible, is the object of the engineer. This is to minimize the number of machines and parts, which would require maintenance, and also reduce mechanical losses. Operating efficiency is of prime importance in industries where the cost of power is a substantial part of the operating cost. The power loss in mechanical speed-reducing equipment varies from two per cent to 15 per cent of the total power transmitted. Because of competitive conditions in all manufacturing lines, it is essential to eliminate any possible power loss. Synchronous motors direct connected to the driven machine eliminate the power loss in speed reducing equipment.

The conservation of floor space is of considerable importance in most manufacturing plants. The use of direct-coupled, motor-driven machinery serves to reduce the floor space required to a minimum.

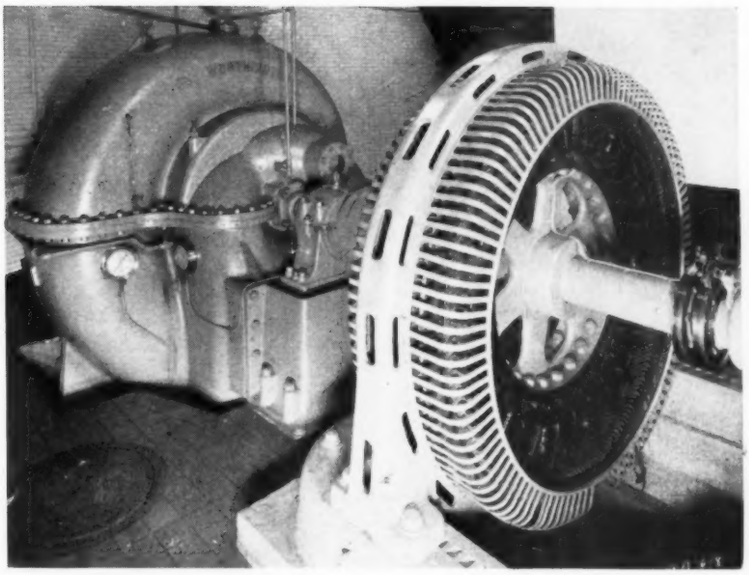
(c) Power factor is a highly technical electrical subject. This was discussed in a previous article, and will be mentioned here, in enumerating the desirable qualities of synchronous motors. The term "power factor" represents the ratio of the electrical energy required by a motor to produce electrical magnets, in certain parts of the machine, to that required to deliver mechanical power at the shaft of the motor. Since small direct current generators, called "exciters" are required with synchronous motors, to produce the magnets, all of the electrical energy taken from the power supply is used in producing mechanical energy, hence the "power factor" of a synchronous motor is 100 per cent or unity. Economically, this high power factor results in reduced losses in the generating, transmission and transformation of electric power. A number of large electric utility companies appreciate the savings which can be made on their power systems, due to high power factor, and for this reason, offer inducements in their rates, to their customers maintaining high power factor.

Induction motors all require a "magnetizing" current as well as a power current, from the electrical power lines. This magnetizing current must either be supplied from the central generating station, or if synchronous motors are installed in the plant, may be supplied from this source. Thus, synchronous motors may not only supply the magnetizing current for their own requirements, but may also for the entire factory.

(d) High efficiency in an electric motor has reference to a reduced ratio of mechanical horsepower output to electrical

Application of MOTORS TO INDUSTRY

WILLIAMSON, *E. E.* » » »



1000-H. P., 277 R. P. M. synchronous motor driving a centrifugal pump in refinery shown.

horsepower input; or less loss within the motor during the conversion from electrical to mechanical energy. The industrial manufacturer should strive to minimize the electric power losses in his motors just as energetically as he endeavors to eliminate any other appreciable loss in his plant. Synchronous motors operate at less losses than induction motors of equal rating, and hence are more efficient. The advantage in favor of the synchronous motor in this respect varies from one to three per cent at full load. The importance of high efficiency depends upon both the cost of power and the number of hours of operation per year; but often the saving in power bills, due to the lower losses in a synchronous motor equals, during the life of the machine, the original investment in the motor.

(e) Synchronous motors, in their earliest form, were awkward and difficult to control. These objections have long since been removed, and the modern synchronous motor is a rugged machine that can be installed anywhere in the plant, operated by unskilled attendants, and will give the same continuous service, low maintenance expense and long life that is realized by induction motors.

In general, the construction of synchronous motors is similar to that of induction motors. The stator, or stationary portion is practically identical, except that for equal rating there are usually fewer coils in the synchronous motor, thus providing air space between ends of coils, and minimum break down at that point. The rotating portion, or rotor of the synchronous motor is similar to a combination of the "squirrel cage" and "slip ring" types of induction motors. The "squirrel cage" winding is provided for starting duty, and is used only for the period of time between start and full speed. The winding of the rotor is connected to two slip rings, which carry the direct current from a small generator, and which is required to produce electro-magnets.

Modern synchronous motor control equipment is push-button operated, thus making the starting operation fully automatic, and removing it entirely from human elements. Relays are provided, designed to perform each operation at the proper time and in the correct sequence. Provision is also made that in case of momentary power failure, the motor may recover its full speed, and carry the load. The control equipment is therefore as simple in operation as that of an automatic starting equipment for induction motors, and simpler than the hand-starting devices.

Direct current excitation must be provided for the synchronous motor. In many industrial plants this is readily available from existing sources. In the case of high-speed motors, an exciter may be direct connected to the end of the shaft; low-speed motors can be supplied by a small, comparatively inexpensive motor generator set.

(f) There is a general impression that synchronous motors are much more expensive than induction motors of a similar rating. This was true during their development period, but increase in production and economies in manufacture have served to narrow the margin of price difference. Many engineers familiar with cost comparisons of ten years ago are greatly surprised at the changes realized in recent years. The modern synchronous motor is justified economically for many applications for which it could not be justified ten years ago.

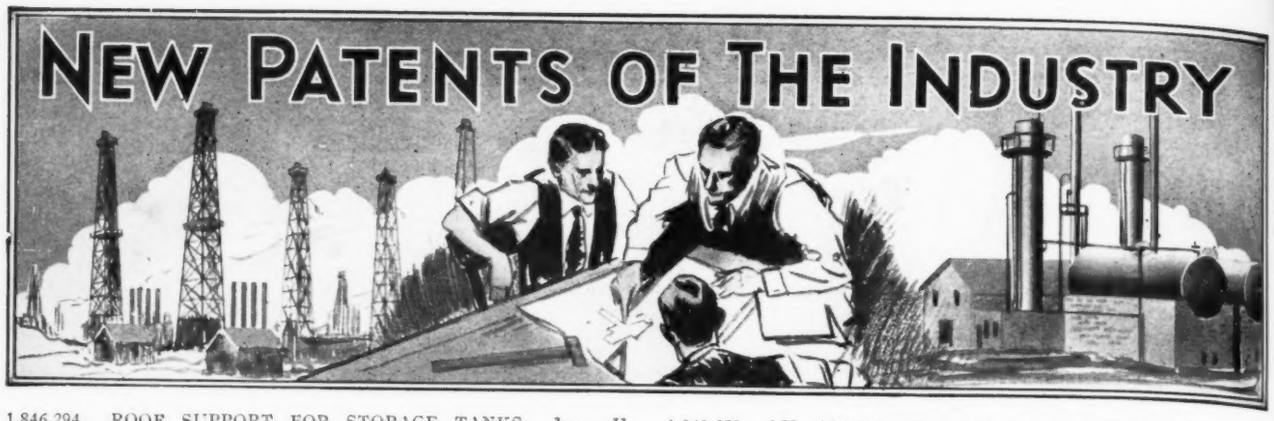
Slow-speed synchronous motors compare favorably in cost to high-speed induction motors, plus the speed reduction equipment required. Also in comparing the cost of synchronous and induction motors, including the control equipment, of relatively low speeds, 514 to 600, it is found that the investment in the synchronous equipment is actually less than that of the induction motor. Thus, no general statement can be made as to the relative cost of these two types of equipments, but comparisons must be made of each specific case.

Synchronous motors are applied to a wide variety of drives in the oil industry. Growing appreciation of the benefits of high power conversion efficiency, power factor correction and direct connection at slow speeds has led to their rapid adoption for compressors, centrifugal and reciprocating pumps, blowers and other motored drives.

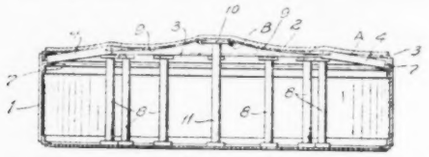
Electric power requirements for oil pipe line pumping are very large. Reciprocating pumps require motor speeds of from 360 to 514 R. P. M. At these speeds synchronous motor efficiencies exceed by a considerable margin those of induction motors, permitting large savings in power costs for pumping. The absolutely constant speed and mechanical ruggedness of synchronous motors are added benefits.

Motors for centrifugal pumps operate at 1200, 1800 and 3600 R. P. M. At 1200 and 1800 R. P. M. the higher efficiencies and power factor, as compared to induction motors, make synchronous motors the preferred drive.

NEW PATENTS OF THE INDUSTRY

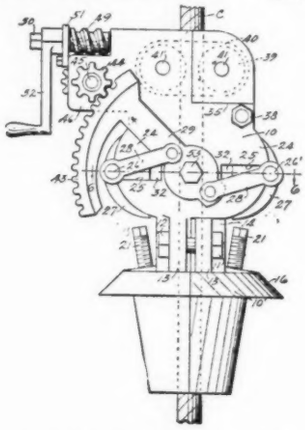


1,846,294. ROOF SUPPORT FOR STORAGE TANKS. JOHN H. WIGGINS, Tulsa, Okla. Filed Feb. 15, 1928. Serial No. 254,518. 1 Claim. (Cl. 220—26.)

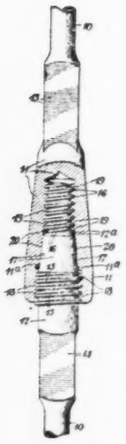


A roof support for storage tanks, comprising roof rafters sustained at their outer ends by the side wall of the tank and projecting inwardly from said side wall, struts combined with said roof rafters so as to cooperate with same to form a framework extending around the top edge of the side wall of the tank and adapted to serve as a bearing for the peripheral portion of the roof, uprights on the bottom of the tank that assist in carrying the load imposed on said framework, a center post in the tank, and tension members extending radially from said center post to said framework so as to form a bearing for the central portion of the roof.

1,849,358. OIL SAVER. HARVEY R. STANDLEE, Tulsa, Okla., assignor to The Guiberson Corporation, Dallas, Tex., a Corporation of Delaware. Filed Oct. 28, 1929. Serial No. 402,851. 9 Claims. (Cl. 286—16.)

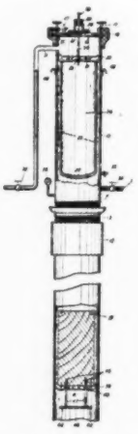


1. In an oil saver, a housing having a vertical packing chamber, compressible packing members located in the packing chamber and having vertical recesses for receiving a movable element to be packed, followers connected with the packing members, levers pivoted on opposite sides of the housing, links pivoted to the followers and also pivoted to the levers, gear segments attached to the levers, and an operating gearing connected with the segments.



1,849,068. SUCKER ROD. LEWIS B. BRIDGES, Madison, N. J., assignor to Dardelet Threadlock Company, New York, N. Y., a Corporation of Delaware. Filed Nov. 14, 1930. Serial No. 495,639. 5 Claims. (Cl. 287—125.)

1. A jointed sucker rod comprising two units having adjacent male and female end portions coupled at two longitudinally spaced points by two pairs of engaged screw threads thereon, said female end portion having an internal annular conoidal non-threaded surface and said male portion having an external annular conoidal non-threaded surface upon which the conoidal surface of the female portion is held forcibly wedged and elastically stretched by the two screw thread connections between the adjacent ends of said screw thread connections, said conoidal surfaces tapering toward the rod axis in the direction of the entering end of the male end portion.

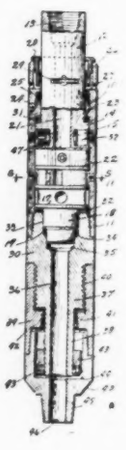


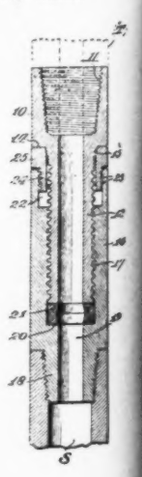
1,849,190. APPARATUS FOR CEMENTING WELLS. ROBERT H. JACKSON, Whittier, Calif. Filed Apr. 18, 1930. Serial No. 445,356. 8 Claims. (Cl. 166—1.)

3. In an apparatus of the class described, a sealing means comprising: a flexible disc adapted to fit snugly within said casing and having an opening there through for the passage of cement fluid; a rigid body normally contacting with the upper surface of said disc and thereby closing said opening, said body having a cross sectional area materially less than that of the interior of said casing, and means for separating said rigid body from said disc and uncovering said opening when any material obstruction in said casing is encountered by said sealing means.

1,846,348. TORSION AND COUPLING CONTROLLING DEVICE. GUSTAVUS A. MONTGOMERY, Dallas, Texas. Filed July 1, 1927. Serial No. 202,791. 12 Claims. (Cl. 64—106.)

1. In a device of the character described, a driving member having a coupling for attachment in a drill stem, a driven member having a coupling for attachment in a drill stem, one of said members being formed with an axial seat and the other member having an end thrust bearing in said seat, and friction clutch shoes rotatably carried by one of said members and engaging with the other member.



1,849,339. SAFETY RELEASING JOINT FOR DRILL TUBES. MAX L. VALLENDOR, Ventura, Calif., assignor of one-fourth to Henry Schwab, one-fourth to C. P. Skinner, and one fourth to Fred Jones, Ventura, Calif. Filed Dec. 26, 1928. Serial No. 328,473. 5 Claims. (Cl. 285—146.)

1. In a safety releasing joint for drill tubes, an externally threaded member, a sub having an internal thread adapted to receive the external thread of said member, a nut screw seated within the upper portion of said sub, the threads between said nut and sub and between said sub and said member being oppositely arranged, and said nut being provided with a face that is adapted to frictionally engage a face on the externally threaded member when the same is screwed into said sub.